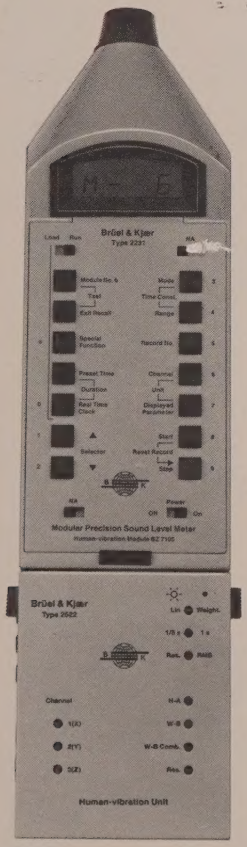
2522
BZ7105
2231

Instruction Manual



Human-vibration Unit and Module

Plus Modular Precision Sound Level Meter

Brüel & Kjær

Chapter 1

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Human-vibration Unit Type 2522
and
Human-vibration Module BZ7105
plus
Modular Precision
Sound Level Meter Type 2231

Type 2522 from serial no. 1469063

Type 2231 from serial no. 1337148

December 1989

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1.1. Description of the Instruments

Modular Precision Sound Level Meter Type 2231 is a precision instrument with a wide range of measurement capabilities. It accepts a wide range of interchangeable modules which enable it to be quickly and easily converted for numerous applications. There are many such modules available for both acoustic and human-vibration measurements.

Human-vibration Unit Type 2522 is a versatile addition to Modular Precision Sound Level Meter Type 2231. It enables direct input from up to three accelerometers at any one time to be measured using the processing power of the sound level meter and the three internal charge amplifiers. To enable it to function, the human-vibration unit requires a relevant application module for the sound level meter; in this case, Human-vibration Module BZ7105. The functions available with Human-vibration Module BZ7105 and Modular Precision Sound Level Meter Type 2231 are shown in Table 1.1.

Function	Channel	Weighting	Linear
Hand-Arm	1–3	H-A	Acc.8-1000 Hz
Whole-Body	1 2 3	W-Bx-y W-Bx-y W-Bz	Acc. 1–80 Hz
Whole-Body Combined	2	W-B Comb.	—

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Table 1.1 Functions available with the human-vibration unit when used with the sound level meter and the human-vibration module

For more information on the characteristics of the instruments, see Appendix A.

1.2. Features

Features of Modular Precision Sound Level Meter Type 2231 with the Human-vibration Module BZ7105 and Human-vibration Unit Type 2522 include:

- Dedicated Hand-Arm, Whole-Body and Whole-Body Combined measurements, weighted in accordance with standards and recommendations.
- Simultaneous triaxial measurements direct from recommended accelerometers.
- Data storage for up to 99 records.
- 5 easy-to-use printout formats of results.
- Manual or automatic control of data storage.
- Wide variety of display parameters.
- Easy-to-read alphanumeric and quasi-analogue display.
- RMS and Peak detection in parallel.
- Internal memory prevents loss of application software and data when the instrument is switched off.
- Facility for connection of Brüel & Kjær Serial Interface Module ZI9101, allowing external control and output of measurement data.

1.3. About This Manual

This Instruction Manual is designed to be used as a reference guide to operation of the instrument. It gives a complete overview of the instrument. To help you to quickly start using the instrument, it is split into the following sections:

Pushkey Directory: Open out the flap on the back cover and refer to the information printed on it while reading the manual: it will help you to become familiar with the instrument layout. It can also be used as a quick reference guide to the function of the pushkeys of the sound level meter when under the control of the human-vibration module.

Introduction: A basic description of the sound level meter and human-vibration unit.

Setting Up: Follow the instructions in this section carefully to ensure accurate measurement procedures.

User Instructions: This is the key section. Read it through so that you become aware of the capabilities of the instruments.

User Guide: This guides the user through a typical human-vibration measurement.

Other Instruments: This section describes which instruments to use in order to get the most of these instruments' measurement and storage capabilities and how to connect them.

Care and Maintenance: Hints for ensuring trouble-free service.

Specifications: The capabilities of the sound level meter and human-vibration unit when used with the human-vibration module.

Appendices: These contain information useful in understanding the finer points of the sound level meter and human-vibration unit.

Note: For use with Human-vibration Unit Type 2522 and Human-vibration Module BZ7105, Modular Precision Sound Level Meter Type 2231 must have a serial number greater or equal to 1337148. Types with earlier serial numbers can be modified by your B&K agent.

1.4. Recommended Reading

The following text is recommended as background reading for those unfamiliar with the field of human-vibration:

»**Human Vibration**«
Brüel & Kjær Booklet BR 0456

For information on the calibration and checking of the sensitivity of accelerometers the following text is recommended:

»**Piezoelectric Accelerometers and Vibration Preamplifiers**«
Brüel & Kjær Instruction Manual BB 0694

2.1. Setting up the Sound Level Meter

This chapter describes the following preliminary procedures necessary for correct setting up of the sound level meter prior to measurement:

Battery installation

Mounting the human-vibration unit

Mounting the microphone socket cap

Connecting the accelerometer

Mounting the front plate and inserting the application module

Sensitivity check

Remember: To ensure the validity of your measurement technique and therefore your results, always follow the relevant national or international standards.

Important: For continuous storage of programs and measurement data, keep the sound level meter switched on for 8 hours (without the human-vibration unit attached) when it is first used.

2.2. Battery Installation

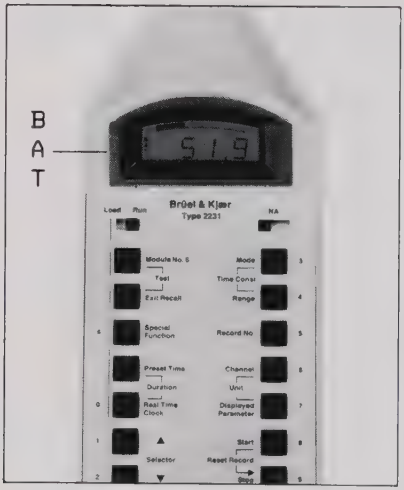

Fig. 2.1. Battery Low display

Battery Type: 1,5 V – IEC type LR6 (B & K No. QB 0013)
No. of Batteries: 8 (4 in the sound level meter, 4 in the human-vibration unit)
Battery Life: Approximately 8 hours (continuous operation – alkaline batteries).
Battery Low: See Fig. 2.1. Flashing "BAT" appears in the display. Replace batteries.

2.2. Battery Installation

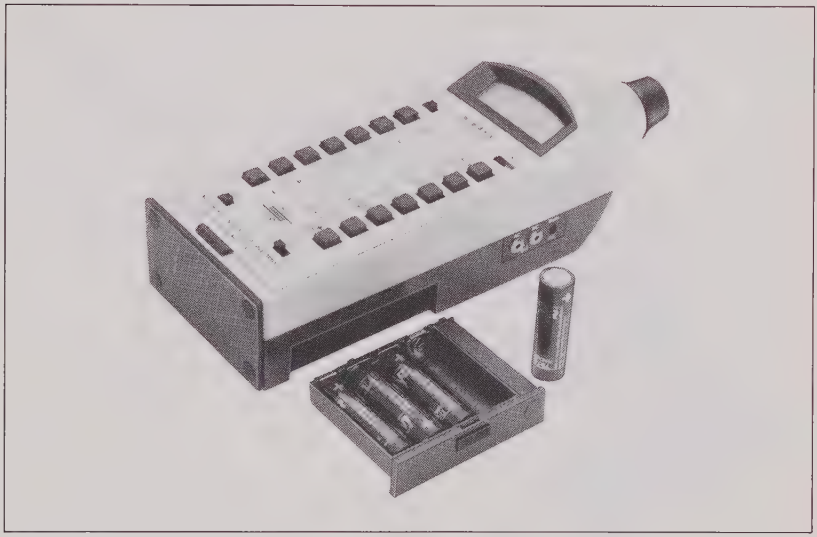

Fig. 2.2. Battery Installation

To install new batteries:

1. Slide battery drawer lock downwards.
2. Remove battery drawer.
3. Insert replacement batteries according to polarity indicated inside drawer.
4. Replace drawer: press in firmly until lock clicks into position.

With Human-vibration Unit Type 2522 connected to the sound level meter, the batteries of the unit are used as a back-up power supply for the sound level meter. With the unit attached, batteries in either the sound level meter **or** the unit may be changed without interrupting a measurement. Replacement of the batteries in the human-vibration unit is as described above.

Note: For long term storage remove the batteries and keep the instruments in a dry place.

2.2. Battery Installation

For retention of application module programs, the sound level meter is equipped with a continuous memory. This has its own back-up battery built in which is automatically recharged when the sound level meter is powered by the batteries contained in the battery drawer. For continuous storage of programs it is sufficient to keep the sound level meter switched on for 8 hours when it is first used. Provided that the back-up battery is kept charged, the main batteries can be removed from the sound level meter without affecting the stored data. When first charging the back-up battery, ensure that the human-vibration unit is not attached to the sound level meter since this uses extra power and the back-up battery will not become fully-charged.

It should be noted that the above charge time is a typical value and applies for operation of the sound level meter at room temperature.

2.3. Mounting the Human-vibration Unit

Connection:

Via a 15 pin connector at the base of the sound level meter.

To Insert Unit:

1. Remove the plastic cover at the base of the sound level meter.

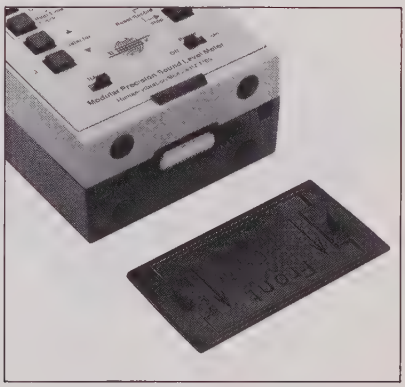

Fig. 2.3. Removal of plastic base cover

2.3. Mounting the Human-vibration Unit

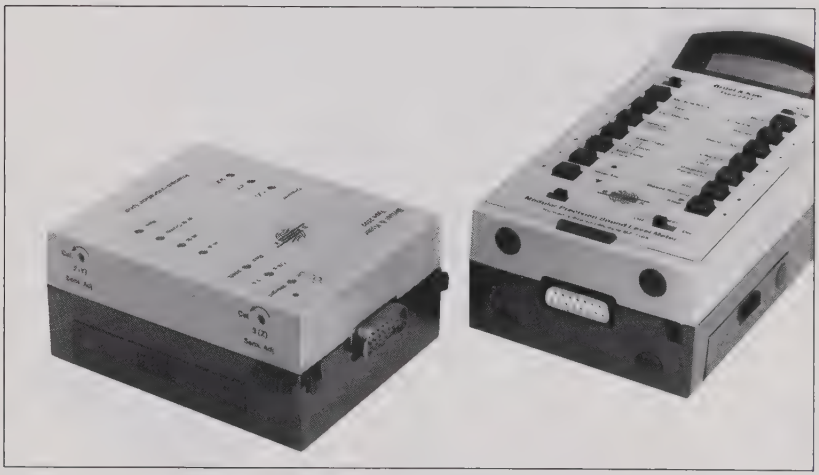

Fig. 2.4. Attachment of the human-vibration unit

2. Squeeze the buttons on the sides of the human-vibration unit and insert the unit's connector firmly into that of the sound level meter. Release the buttons; if they return out fully then the human-vibration unit will remain locked in position.

When the human-vibration unit is connected, its batteries are used as a back-up power source for the sound level meter.

Disconnection of the human-vibration unit is the reverse of the procedure described above.

2.4. Accelerometer Mounting

Before mounting any accelerometer be sure to observe the following precautions:

- Make sure that the power to the sound level meter is off
- Use only light finger torque for attachment of accelerometers, adaptors and extension cables etc.

Mounting the Accelerometers:

1. Gently screw each accelerometer onto the desired channel connector on Input Adaptor AO 0312 supplied. Make sure that the accelerometers are attached to the correct connectors (see overleaf).
2. Gently screw Input Adaptor AO 0312 into the 6-pin DIN socket on the side of the human-vibration unit as shown in Fig. 2.5.

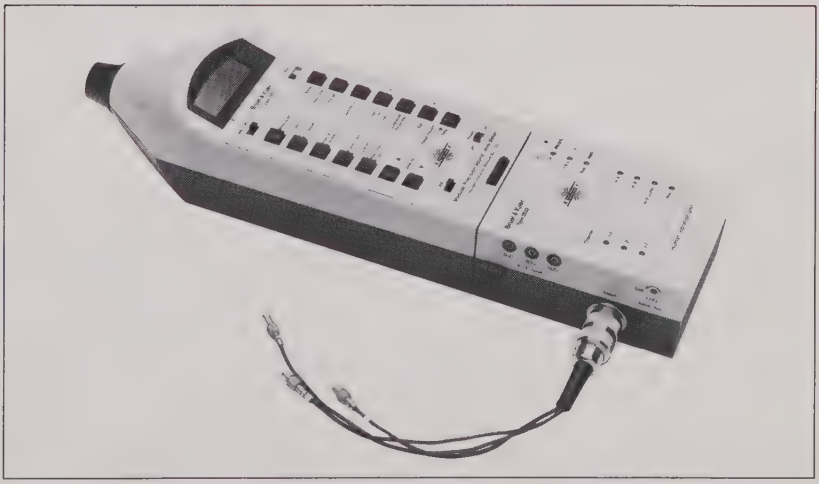

Fig. 2.5. Connection of Input Adaptor AO 0312 to the human-vibration unit

2.4. Accelerometer Mounting

Note:

1. Triaxial Seat-Accelerometer Type 4322 is fitted with the correct 6-pin DIN plug for connection to the human-vibration unit and has, therefore, no need for Input Adaptor AO 0312. It should be connected as described in step 2 above.
2. The connectors on Input Adaptor AO 0312 are marked 1, 2 and 3 which correspond to channels X, Y and Z of the human-vibration unit respectively.
3. For monaxial measurements, the accelerometer must be attached to connector 2 of the adaptor. Fit the unused connectors of the adaptor (1 and 3) with the Screening Caps YM 0420 described in section 2.5.

The sound level meter and human-vibration unit can operate with almost any accelerometer in the Brüel & Kjær range. The human-vibration unit, however, contains charge amplifiers for each measurement mode which correlate to the recommended accelerometers described in Appendix B to give correct measurement results.

2.5. Mounting the Screening Caps

There are two types of screening caps available. Screening Caps YM0420 fit the 10–32 UNF connectors of Input Adaptor AO0312 and are used to suppress electrical noise and protect the connectors from dirt. Socket Cap YJ0217 protects the input stage socket of the sound level meter from dirt.

Before mounting Socket Cap YJ0217, remove Input Stage ZC0020 by unscrewing the threaded retaining ring and pulling it directly out of the socket at the top of the sound level meter.

The Socket Cap YJ0217 simply fits directly over the input stage socket of the sound level meter.

Note: The sound level meter can still be operated with the human-vibration unit and human-vibration module even if the input stage is inserted into its socket. It is recommended, however, that the socket cap be used to prevent risk of damage to the microphone.

2.6. Attaching the Front Plate and Application Module

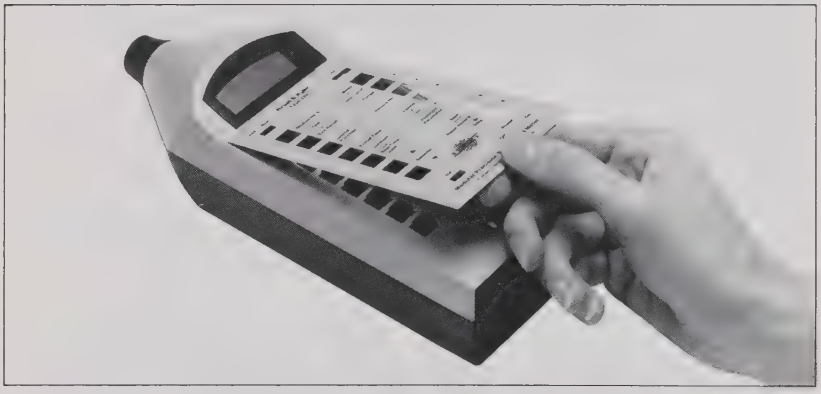

Fig. 2.6. Mounting the front plate

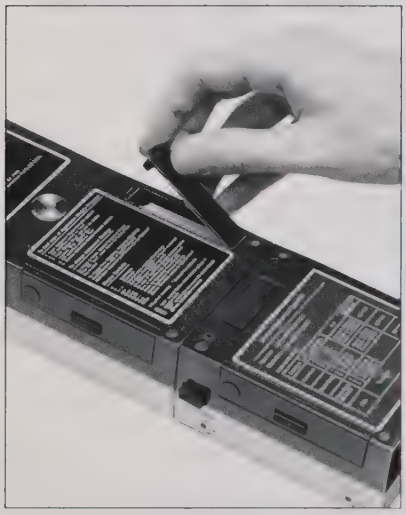

Fig. 2.7. Removal of plastic cover

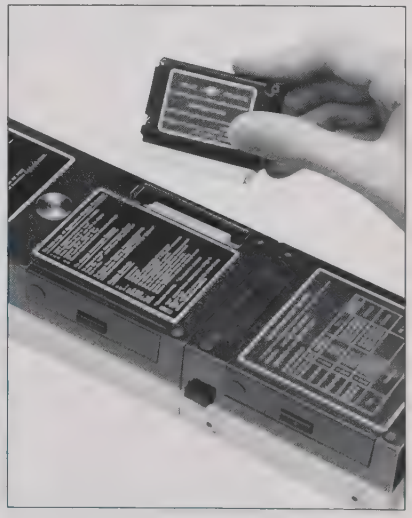

Fig. 2.8. Insertion of module

Note: When not in use ensure that the module terminals are fitted with the black plastic discharge template. This will protect the module from static electricity.

2.7. Checking Sensitivity

Modular Precision Sound Level Meter Type 2231 and Human-vibration Unit Type 2522, together with Human-vibration Module BZ7105, are set up so that calibrated results may be obtained with certain types of accelerometer, in certain measurement modes, as described in Appendix B. All accelerometers recommended, except Type 4374, are Uni-gain® and, therefore, their sensitivity need only be checked to verify that they have not been damaged during previous use. Use of the meter with accelerometers with sensitivities different from those listed in Appendix B is not recommended since the sound level meter will not display the correct vibration level.

Fig.2.9. Sensitivity check set up of the sound level meter and the human-vibration unit using Calibration Exciter Type 4294

2.7. Checking Sensitivity

Checking the sensitivity of the human-vibration unit and sound level meter can be achieved with Calibration Exciter Type 4294 by the following procedure:

1. Ensure that the sound level meter is calibrated for use with a microphone with a K-factor of 0,0 dB using the internal generator as instructed in the instruction manuals for Application Modules BZ7100 and BZ7101
2. Connect an accelerometer with a sensitivity of approximately 0,1 pC/ms^{-2} (e.g. B&K Type 4374) to the calibration exciter as instructed in the calibrator's Instruction Manual
3. Connect the accelerometer, via Input Adapter AO0312, to Channel 1 (X) of the human-vibration unit
4. Switch on the sound level meter
5. Using the keypad of the sound level meter, set up the measurement parameters (as described in Chapter 3 - Operating Instructions) as follows:

Special Function	: F000
Mode	: HA:LT
Time Constant	: 1s
Range	: HIGH
Channel	: X
Unit	: m/s^2
Displayed Parameter	: INST

6. Switch on the calibrator
7. Using the potentiometer marked **Sens. Adj. 1 (X)** on the side of the human-vibration unit, adjust the sensitivity of the unit until the display shows **10.0**
8. Switch off the calibrator and the sound level meter
9. Repeat for Channels 2 (Y) and 3 (Z)

2.7. Checking Sensitivity

The sensitivity of each channel can be varied by approximately ± 10% using separate potentiometers. If a potentiometer is turned from its "calibrated" position which is at the anticlockwise end stop, as shown in Fig. 2.10, the sensitivity will first decrease and then increase past the "calibrated" sensitivity level.

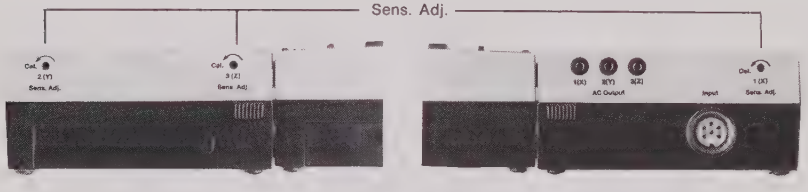

Fig.2.10. Side Views of the human-vibration unit showing the Sensitivity Adjust potentiometers for the X, Y and Z Channels (1, 2 and 3 respectively)

Chapter 3

Human-Vibration Module BZ7105 User Instructions

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3.1. The Human-vibration Module

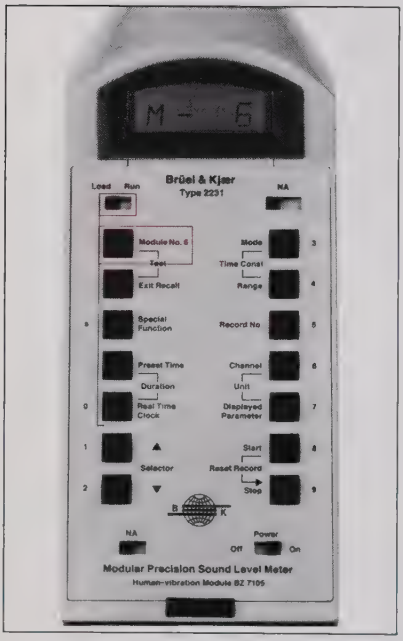
Fig. 3.1. Human-vibration Module BZ 7105

With Human-vibration Module BZ 7105, Modular Precision Sound Level Meter Type 2231 and Human-vibration Unit Type 2522 combine to become a human-vibration measurement set. Some of the potential uses in this configuration are:

- Measurement of human-vibration based on standardized criteria.
- Monitoring of vibration for assessment of health risk such as Raynaud's phenomenon (vibration induced white finger).
- Measurements in the design, development and inspection of passenger/work vehicles and powered hand-tools.
- Data recording for future analysis.
- Measurements in permanent or temporary situations.
- Laboratory or field measurements.

3.2. Loading the Module

- Attach the front plate supplied with the human-vibration module as shown in section 2.6
- Insert the human-vibration module into the back of the sound level meter as shown in section 2.6



1. Set **Load/Run** to **Load** .
2. Press **Module No. 6** . The program is loaded from the human-vibration module into the internal program- and data- memory. Once loaded, the program number M-6 is displayed as shown. The module may now be removed, and the black plastic dust cap replaced.
3. Set **Load/Run** to **Run** to begin execution.

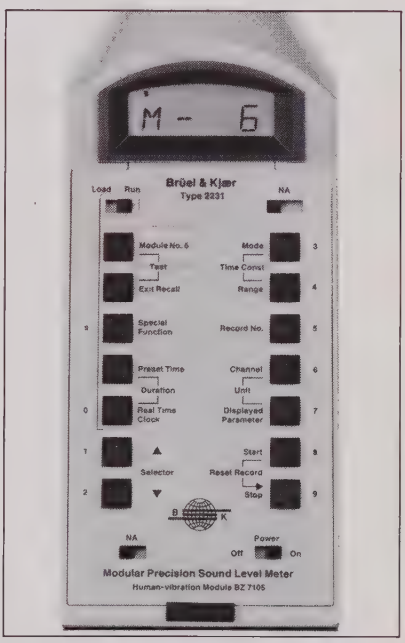
Note: Every time the module is loaded, the **Special Function**, **Preset Time**, **Duration** and **Real Time Clock** are reset to zero. Other parameters are initialized by the instrument as follows:

Mode	: "HA:WT"
Range	: "High"
Displayed Parameter	: "Inst"
Time Constant	: "1 s"
Unit	: ms^{-2}
Channel	: "X"
Record No.	: "1"

3.3. Checking the Module Status

1. Set **Load/Run** to **Run**.
2. Press **Module No. 6**.

The display should read M-6 as shown. This signifies that the program currently residing in the central memory was loaded from Human-vibration Module BZ7105. Other numbers (such as "M-1", "M-2" etc.) are assigned to programs which may be loaded from alternative modules in the series. Only one application software may be stored at any one time in the sound level meter memory. When a new application module is loaded, its software replaces the software existing there.



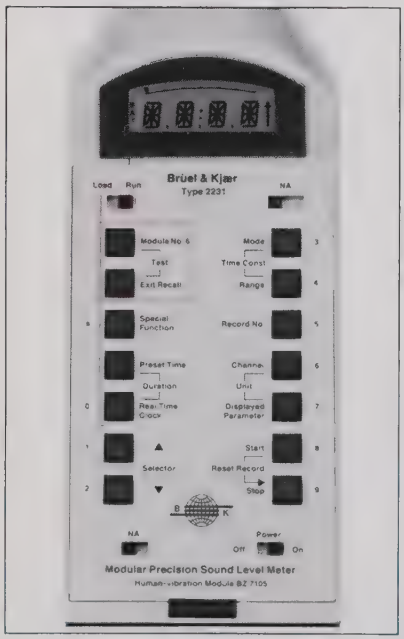
Note: Always ensure that the front plate for Human-vibration Module BZ7105 is mounted on the sound level meter when the display reads "M-6" on checking the module status. The functions associated with each pushkey are defined by the software in the central memory, and are not the same for each module.

3.4. Test

Test initiates a test of the digital display. Each segment of each digital character is displayed, along with the Overload symbol (↑) and the Battery Low symbol (BAT). The quasi-analogue portion of the display is unaffected by **Test** and continues to register the level of the incoming signal.

Test can be activated without disturbing a measurement in progress.

To Initiate Test:



1. Set **Load/Run** to **Run** .

2. Press **Test** .

Test is activated by pressing both pushkeys that are linked with the **Test** logo (the pushkeys are also labeled **Module No. 6**, and **Exit Recall**).

3.5. Duration

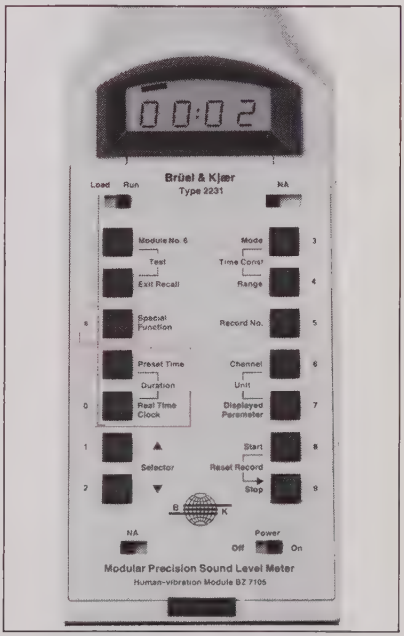
Pressing **Duration** enables the operator to determine the length of the current record.

To Check Duration:

1. Press **Duration** (Display shows **Duration** in hours and minutes - hh:mm).

2. While keeping **Duration** depressed, press **s** (Display shows **Duration** in seconds - ss).

Duration is activated by pressing both pushkeys that are linked with the **Duration** logo (the pushkeys are also labeled **Preset Time**, and **Real Time Clock**).



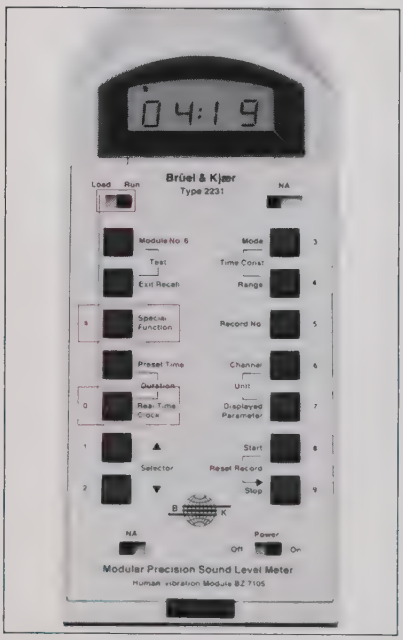
3.6. Real Time Clock

The **Real Time Clock** function permits the determination of the time after it has been set up by the user. On loading of Human-vibration Module BZ7105, it is automatically set in operation from zero. It will run unless one of the following conditions occurs:

- The power to the sound level meter is off.
- The Monitor program is in use (e.g. when transferring data via the Digital Output).

When either of these situations occurs, the **Real Time Clock** will pause until either the power is switched on again or the sound level meter is no longer under the control of the Monitor program.

Checking and Changing the Real Time Clock:



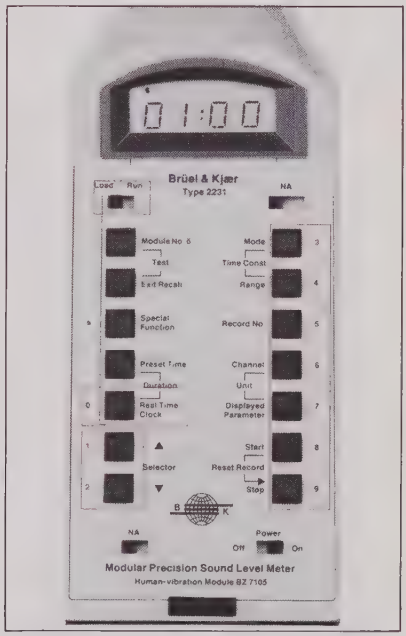
Checking:

1. Set **Load/Run** to **Run** .
2. Press **Real Time Clock** (Display shows **Real Time Clock** in hours and minutes - hh:mm).
3. While keeping **Real Time Clock** depressed, press **s** (Display shows **Real Time Clock** in seconds - ss).

3.6. Real Time Clock

Changing:

1. Set **Load/Run** to **Load**.
2. Press **Real Time Clock** (Display shows 00:00-hh:mm).
3. Use keys **0** to **9** to key in hh:mm of the **Real Time Clock**. When the digits are keyed-in, they are shifted along the display from right to left.
4. Set **Load/Run** to **Run**.



Note: Checking the **Real Time Clock** does not interrupt or affect the measurement in progress. Changing it causes the current record to be reset as if **Reset Record** had been depressed.

3.7. Mode

Seven measurement modes are built in. These have the characteristics given in chapter 7 - Specifications and are indicated by the following symbols:

HA:WM -	Hand-Arm monaxial mode – weighting complying with ISO 5349
HA:LM -	Hand-Arm monaxial mode – linear weighting between 8 and 1000 Hz
HA:WT -	Hand-Arm triaxial mode – weighting complying with ISO 5349
HA:LT -	Hand-Arm triaxial mode – linear weighting between 8 and 1000 Hz
WB:WT -	Whole-Body triaxial mode – weighting complying with ISO 2631/1
WB:LT -	Whole-Body triaxial mode – linear weighting between 1 and 80 Hz
WB:CW -	Whole-Body Combined monaxial mode – weighting complying with ISO 2631/2

In addition, the Lin/Weight light on the human-vibration unit displays the status of the **Mode**. The light is on for any linearly weighted modes and off for any modes that are frequency weighted.

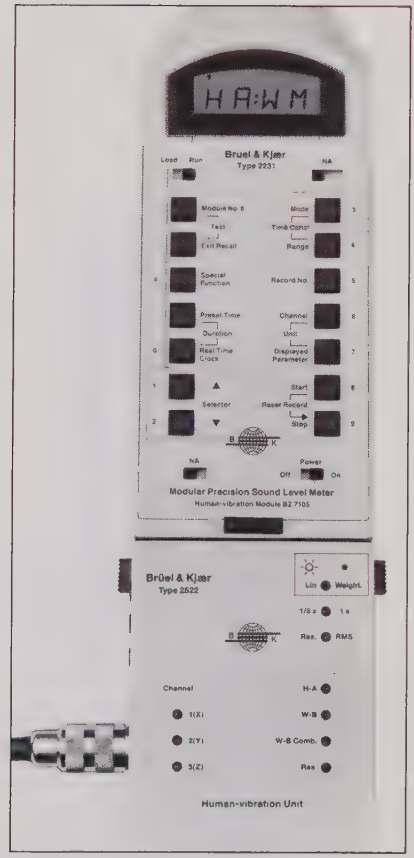
The AC Output from the human-vibration unit is frequency weighted according to the mode employed (see Appendix A - Instrument Characteristics).

3.7. Mode

Checking and Changing the Mode:

Checking:
Press **Mode**.
The selected **Mode** is displayed for about 1 s (i.e. for the remainder of the sample period in which the key is released).

Changing:
Press **Mode** plus **Selector ▲** or **Selector ▼** simultaneously. **Selector ▲** will step the status of **Mode** forward through the above list whilst **Selector ▼** will step it in the opposite direction through the above list.



Note: The status of each of the weighting and time constant lights on the human-vibration unit is explained on the instrument itself. With the light lit (denoted by ☼), the text to the left of the light shows its status. With the light unlit (denoted by ●), the text to the right of the light shows its status.

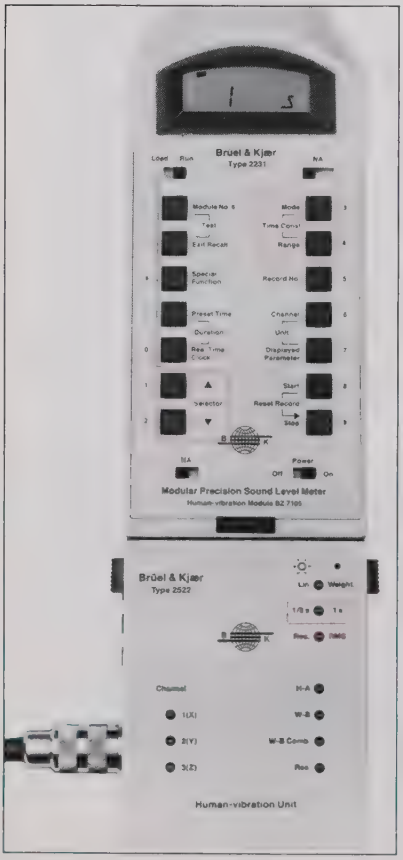
3.8. Time Constant

The following time constants of the signal detector may be applied to the incoming signal:

1 s 1/8 s

The 1/8 s / 1 s light on the human-vibration unit displays the status of the **Time Constant**. For a **Time Constant** of 1/8 s the light is on. It is off for a **Time Constant** of 1 s.

Checking and Changing the Time Constant:



Checking:
Press **Time Const.** .
Time Constant is activated by pressing both pushkeys that are linked with the **Time Constant** logo (the pushkeys are also labeled **Mode** and **Range**).
The selected **Time Constant** is displayed for about 1 s (i.e. for the remainder of the sample period in which the key is released).

Changing:
Press **Time Const.** plus **Selector ▲** or **Selector ▼** simultaneously.

3.9. Range

The following two measurement ranges, whose sensitivities vary with the **Mode** as shown in chapter 7 - Specifications, may be selected:

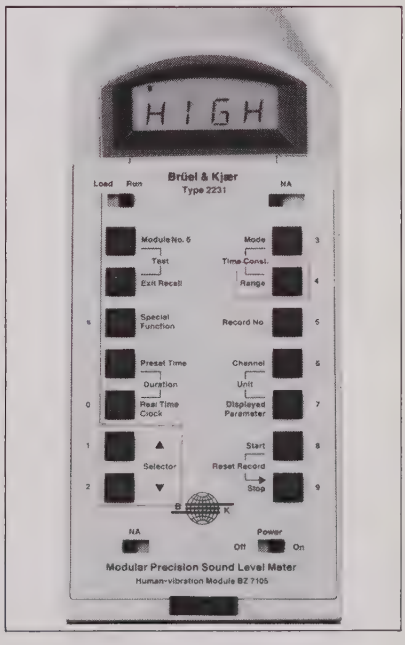
"High" "Low"

The "High" **Range** is 10 times (20 dB) less sensitive than the "Low" **Range**.

Checking and Changing the Range:

Checking:
Press **Range** .
The selected **Range** is displayed for about 1 s (i.e. for the remainder of the sample period in which the key is released).

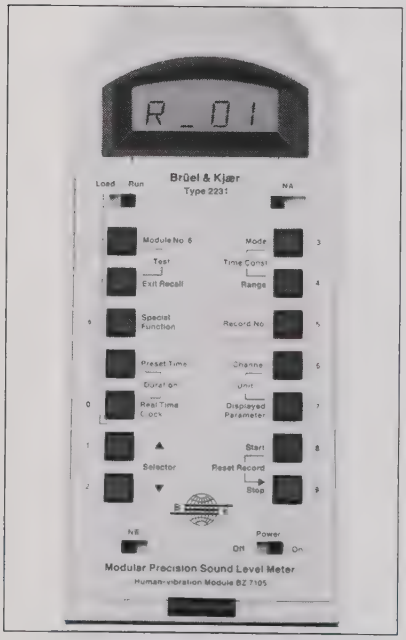
Changing:
Press **Range** plus **Selector ▲** or **Selector ▼** simultaneously.



3.10. Record Number

There is room for 99 records in the data store. Each record contains measurement data and parameters. At the end of a measurement period, whose length is defined by the user, the measurement data and parameters are stored in the current record. Future measurement data and parameters are stored in the next record (see section 3.16 - Stop).

Checking the Record Number:



Press **Record No.** .
The current **Record Number** is displayed for about 1 s (i.e. for the remainder of the sample period in which the key is released).

The **Record Number** changes automatically when pressing the **Stop** pushkey (see section 3.16 - Stop).

3.11. Channel

Four settings are available for display of measurements with the respective input channels of the human-vibration unit. These are:

"X" "Y" "Z" "Sum"

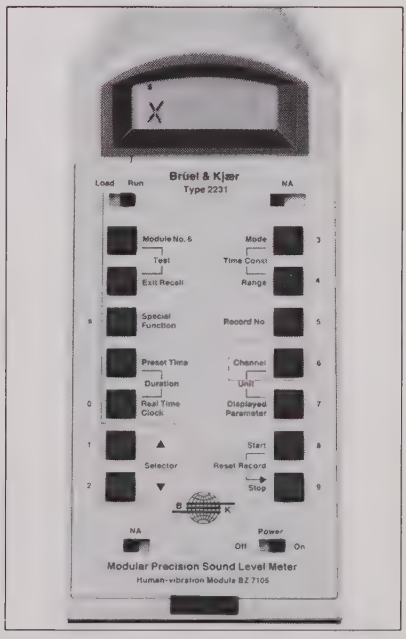
The "Sum" setting is only available when the displayed parameter is **a_{eq}** (for further details about a_{eq} and "Sum" see Appendix C - Description of a_{eq}). The channels "X", "Y" and "Z" are also labeled "1", "2" and "3" respectively on the human-vibration unit.

When a channel which is not applicable for measurement is selected, the display shows **NA** (Not Applicable).

Checking and Changing the Channel:

Checking:
Press **Channel**.
The selected **Channel** is displayed for about 1 s (i.e. for the remainder of the sample period in which the key is released).

Changing:
Press **Channel** plus **Selector ▲** or **Selector ▼** simultaneously.



Note: Checking and changing the **Channel** status does not interrupt nor affect the measurement in progress.

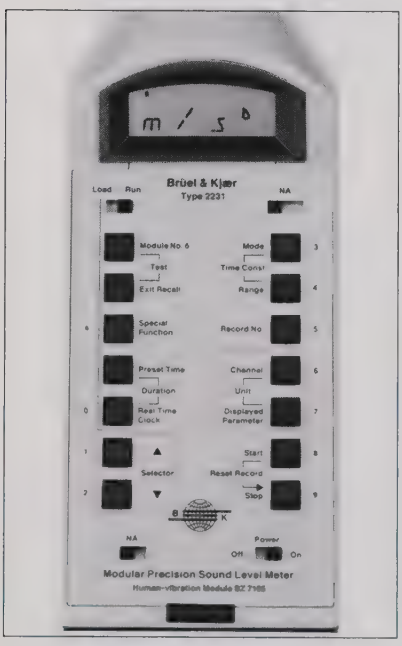
3.12. Unit

Three measurement units can be selected for display of the input signal on the sound level meter display. The following symbols are used to indicate the selected measurement unit:

m/s²	: ms^{-2}
K	: K (as defined by DIN 45 671)
dB	: dB (reference level $1\mu ms^{-2}$)

When a unit which is not applicable for measurement is selected, the display shows **NA** (Not Applicable).

Checking and Changing the Unit:



Checking:
Press **Unit** .
The selected **Unit** is displayed for about 1 s (i.e. for the remainder of the sample period in which the key is released).

Changing:
Press **Unit** plus **Selector ▲** or **Selector ▼** simultaneously.

Note: Checking and changing the **Unit** status does not interrupt nor affect the measurement in progress.

3.13. Displayed Parameter

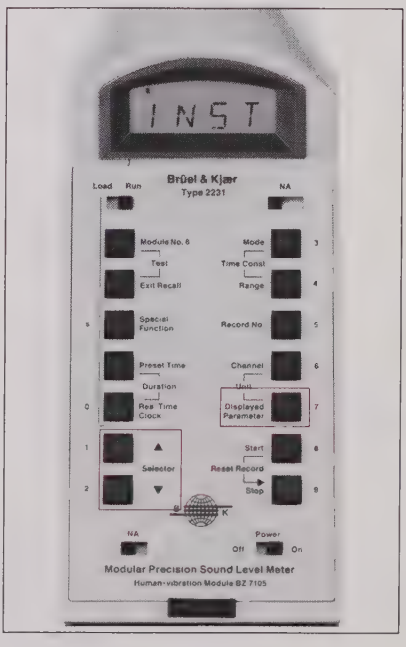
With Human-vibration Module BZ7105, the sound level meter can display any of the following parameters associated with the incoming signal:

MAXP	: Maximum Peak level
PEAK	: Maximum Peak level in 1 second interval
INST	: Sampled RMS level in 1 second interval
MINL	: Minimum RMS level
AEQ	: a_{eq}
MAXL	: Maximum RMS level

Checking and Changing the Displayed Parameter:

Checking:
Press **Displayed Parameter**. The status of the currently selected **Displayed Parameter** is displayed (see the example opposite) for about 1 s (i.e. for the remainder of the sample period in which the key is released).

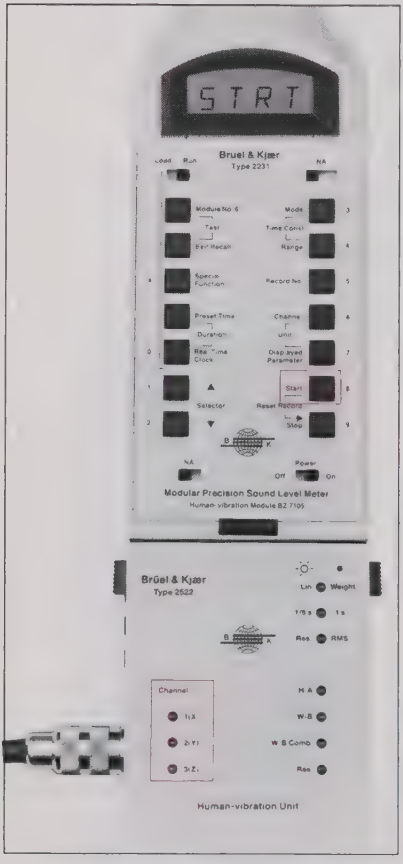
Changing:
Press **Displayed Parameter** plus **Selector ▲** or **Selector ▼** simultaneously. The selected **Displayed Parameter** is displayed for about 1 s (i.e. for the remainder of the sample period in which the **Displayed Parameter** push-key is released). Then the corresponding measured value for that function is displayed.



Note: Checking or changing the **Displayed Parameter** status does not interrupt nor affect the measurement in progress.

3.14. Start

Starting a Measurement Record:



Press **Start**.
A new measurement is started and the results stored in the current record together with the start time given by the **Real Time Clock**.

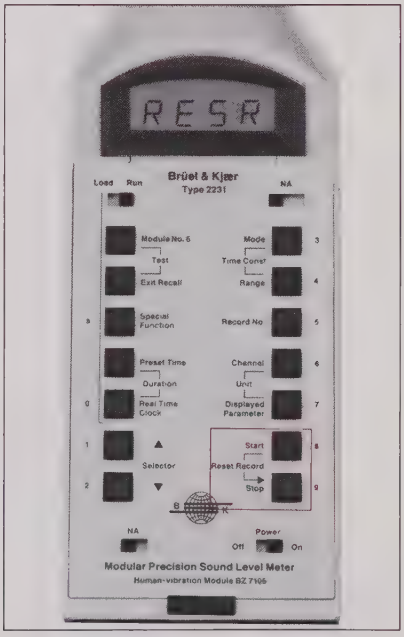
Starting a record causes the appropriate channel lights on the unit to light. For a monaxial mode, only the Y Channel (channel 2) light will be lit. For a triaxial mode, all three Channel lights (X, Y and Z) will be lit.

3.15. Reset Record

Pressing **Reset Record** causes a new measurement to be initiated with a new start time on the current record. The status of **Special Function**, **Preset Time**, **Real Time Clock**, **Mode**, **Time Constant**, **Range**, **Channel**, **Unit** and **Displayed Parameter** are NOT changed.

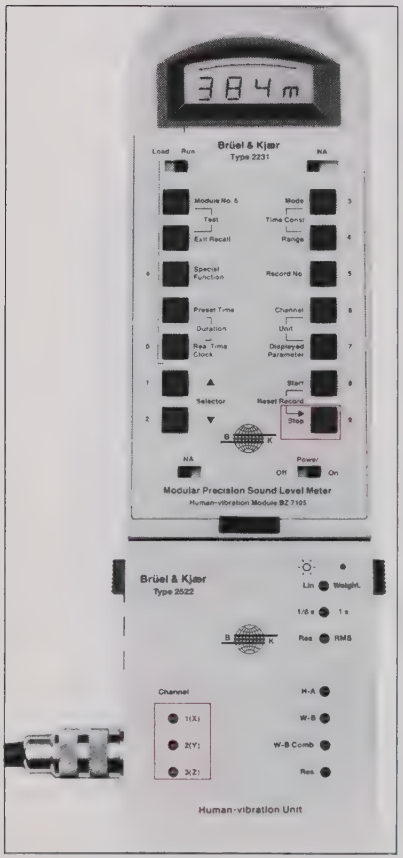
To Reset the Current Record:

Activate **Reset Record** by pressing **Start** and then, whilst keeping it depressed, pressing **Stop**. Avoid pressing **Stop** first as only the **Stop** mode will be activated. This will cause unwanted data to be stored and access to a record will be lost. An arrow on the front plate indicates the order of depression.



3.16. Stop

Stopping a Record:



Press **Stop**.
The current record will be closed with all relevant data in the assigned places in the data store (see section 3.17.2 - Recall - for the relevant data stored). The next consecutively numbered record will be opened ready for data to be sent to it at the start of a new measurement.

Note: When stopped, the channel lights on the unit are extinguished and the quasi-analogue display on the meter is stopped.

3.17. Special Functions

The **Special Function** facility on the sound level meter allows the user to make minor modifications to the standard program. These modifications are implemented by keying-in a three digit code. They can be conveniently grouped as follows:

1. Control of the digital and DC outputs,
2. Control of the data store.

The available modifications and the appropriate code for each are listed overleaf.

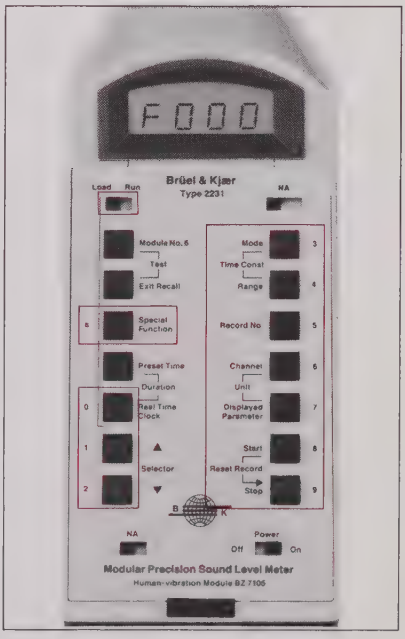
Checking and Changing the Special Function:

Checking:

1. Set **Load/Run** to **Run**.
2. Press **Special Function** (displays currently selected **Special Function**).

Changing:

1. Set **Load/Run** to **Load**.
2. Press and release **Special Function** (displays F000 - the default value - as shown).
3. Use keys **0** to **9** to enter the **Special Function** code. When the digits are keyed-in, they are shifted along the display from right to left.
4. Set **Load/Run** to **Run**.



Note:

1. Checking the status of the **Special Function** facility does not interrupt nor affect the measurement in progress.
2. Changing the **Special Function** causes the current record to be reset.

3.17. Special Functions

3.17.1. Special Function Directory

A three digit code (e.g. 100 or 304) is used to enable a **Special Function**. The first digit (**1**00 or **3**04) determines the characteristic that the **Special Function** will control (e.g. the display, digital output, DC output or the data store). The second and third digits (represented by XX below) set the record number (01 to 99) that is output (e.g. 2**3 1** displays record number 31).

The **Special Function** codes are:

000 : Manual data-storage control (see section 3.16 - Stop).

100 : Automatic data-storage control (see section 3.19 - Preset Time).

2XX : Displays a record (see Note 1).

3XX : Print Format 1 for digital output of the record with the number defined by the final two digits (see Note 2).

4XX : Print Format 2 for digital output of the record with the number defined by the final two digits (see Note 2).

5XX : Print Format 3 for digital output of the record with the number defined by the final two digits (see Note 2).

6XX : Print Format 4 for digital output of the record with the number defined by the final two digits (see Note 2).

7XX : Print Format 5 for digital output of the record with the number defined by the final two digits (see Note 2).

800 : DC output of the calibration signal (see Note 3).

999 : Erases all records.

3.17. Special Functions

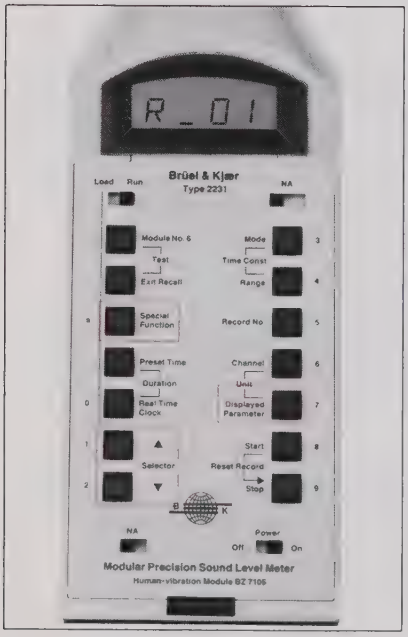
The **Special Function** directory is also printed on the back of the front plate.

Note:

1. If 2**0 0** is entered, the input will be interpreted as 2**0 1** and record number 1 will be recalled to the display of the sound level meter. If the number of the current record is equal to or lower than the last two digits, then the last complete record (the one with the highest number) will be recalled. If no records have been stored, the **Recall** command is ignored and **Special Function** is set to 0 0 0.
2. To obtain a digital output, Interface Module ZI 9101 must be connected (see section 5.4 - Interface Module ZI 9101). If X**0 0** is entered (where X = 3 to 7), all records stored in the data store will be printed in the chosen format. If the number of the current record is equal to or lower than the last two digits, then the last complete record (the one with the highest number) will be printed via the digital output of the sound level meter. If no records have been stored, the output will be **No Record**.
3. With **Load/Run** set to **Run**, the calibration signal at the DC Output will be set to alternate at 1 second intervals between 0 and 2,5 V (see section 3.17.5 - Calibration Signal and section 5.1 - Level Recorder Type 2317).

3.17. Special Functions

3.17.2. Recall



All records in the data store can be recalled to the display of the sound level meter using **Special Function 2XX** as described in section 3.17 - Special Functions. When the switch is set to **Run** the display will show R XX as shown, where XX is the recalled **Record Number**.

When in the Recall mode, operation via the sound level meter keypad is greatly reduced. **Channel**, **Unit**, **Displayed Parameter** and **Exit Recall** can still be operated as described in the relevant sections (3.11, 3.12, 3.13 and 3.17 respectively) but the parameters accessed with the **Displayed Parameter**, **Selector ▲** and **Selector ▼** keys are slightly different to those described for normal operation. The other pushkeys cannot be used whilst in the Recall mode.

3.17. Special Functions

The following symbols are used to indicate the selected parameters which have been stored in the relevant record and are available in the Recall mode:

R No	: Recalled **Record Number**
MODE	: Measurement **Mode** used
TC	: Detector **Time Constant**
MAXP	: Maximum peak signal (in channels X, Y and Z)
MAXL	: Maximum signal level (in channels X, Y and Z)
AEQ	: a_{eq} (in channels X, Y, Z and "Sum")
MINL	: Minimum signal level (in channels X, Y and Z)
STRT	: Start time as defined by the **Real Time Clock**
DURA	: **Duration** of the record

When **Start** and **Duration** are recalled in a record, the display shows the hours and minutes (hh:mm). The seconds can be displayed by depressing key **s**. When the **s** key is released the display will return to its original setting. The **Max. Peak**, **Max. Level** and **Min. Level** of all three channels are available (where applicable), whilst $\mathbf{a_{eq}}$ is available in all three channels as well as "Sum" (where applicable).

When the **Exit Recall** key is depressed, the sound level meter is returned to its previous status. The **Duration** of the current record, if one has been started, is reset to zero.

3.17. Special Functions

3.17.3. Digital Output

For a digital output from the sound level meter and human-vibration unit, Interface Module ZI9101 must be connected where the human-vibration module was previously inserted (see section 3.20 - Interfacing the Sound Level Meter, section 5.2 - Graphics Printer Type 2318 and section 5.4 - Interface Module ZI9101).

Five print formats are accessible with the human-vibration module, two of which can only be used with Graphics Printer Type 2318. The formats are more fully described in section 3.17.4 - Printout Formats.

To activate printout of a record first ensure that the sound level meter is in Stop mode to prevent cancellation of the current record and then enter the special function code for the required format and record to be printed via the digital output (see section 3.17.1 - Special Function Directory). A printout is obtained immediately after the special code is entered. After printout, **Special Function** will be set to its default value of **F000**.

Note: The digital output can be interrupted by switching the sound level meter to **Load**. On switching back to **Run**, it resumes the status that it had prior to the input of **Special Function**.

3.17. Special Functions

3.17.4. Print Formats

Print Format 1 (F3XX).

This print format can ony be used with Graphics Printer Type 2318. It presents all the measurement results and parameters in a comprehensive fashion with a heading, space for notes and an indication of whether overload has occurred or not.

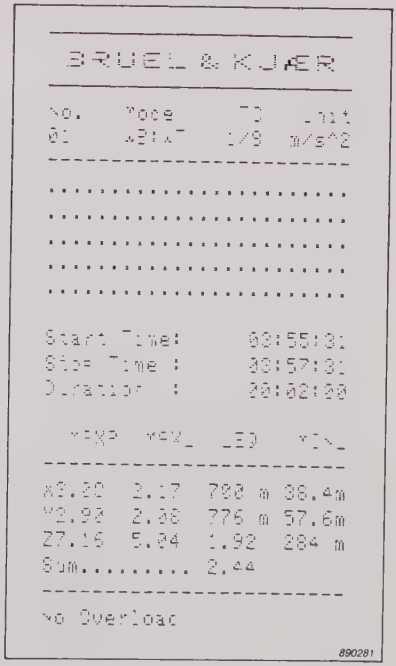


Fig. 3.2. Example of Print Format 1

3.17. Special Functions

Print Format 2 (F4XX).

This print format is the same as print format 1 but does not contain space for notes.

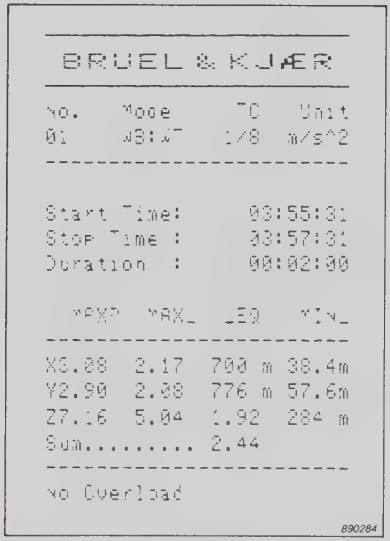


Fig. 3.3. Example of Print Format 2

3.17. Special Functions

Print Format 3 (F5XX).

This print format can be used with any RS–232–C equipment. It is the same as print format 1 except that the solid lines about the header are replaced by dashed lines.

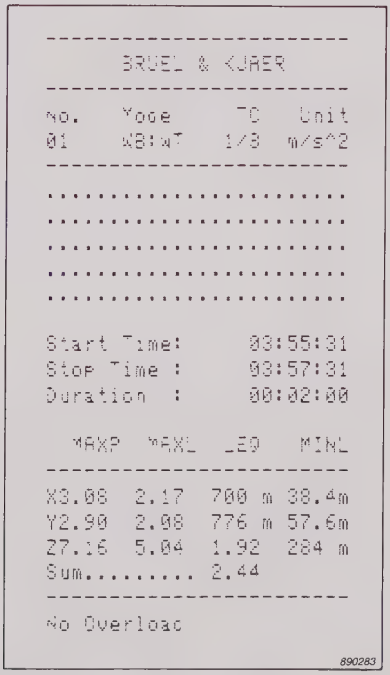


Fig. 3.4. Example of Print Format 3

3.17. Special Functions

Print Format 4 (F6XX).

This print format can be used with any RS–232–C equipment. It is the same as print format 2 except that the solid lines about the header are replaced by dashed lines.

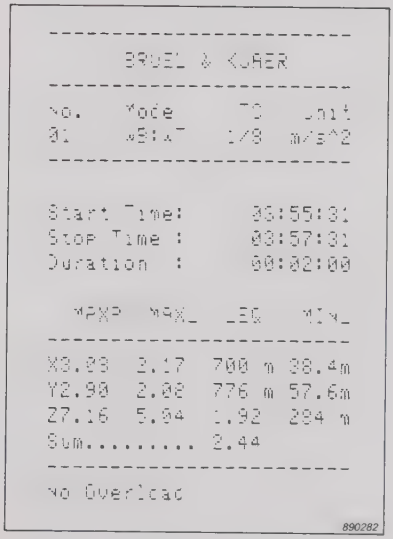


Fig. 3.5. Example of Print Format 4

3.17. Special Functions

Print Format 5 (F7XX).

This print format can be used with any RS–232–C equipment. It is a short format containing all the measurement results and parameters.

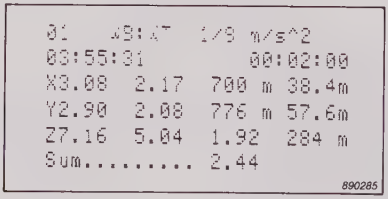


Fig. 3.6. Example of Print Format 5

3.17. Special Functions

3.17.5. Calibration Signal

When **Special Function** is set to F800, the potential across the DC output of the sound level meter alternates between 0 and 2,5 V at 1 second intervals (see Fig. 5.6). This can be used to calibrate Portable Level Recorder Type 2317 prior to recording.

3.17.6. Delete Data Store

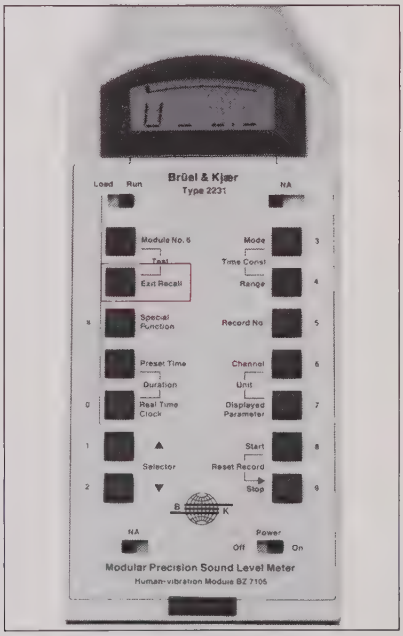
When **Special Function** is set to F999, the entire data store of the sound level meter is erased. The current record marker will be set to 01 upon starting a new record.

3.18. Exit Recall

The **Exit Recall** key is only operational when the sound level meter is in the Recall mode, otherwise it has no effect. Depressing **Exit Recall** returns the sound level meter to the parameter set-up it was in prior to entering the Recall mode.

Exiting Recall Mode:

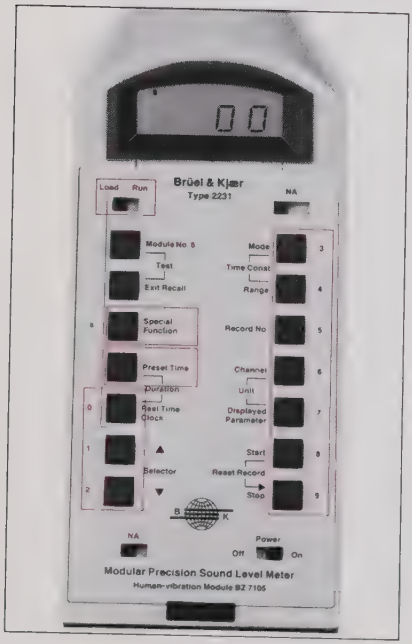
Press **Exit Recall** .
If the sound level meter is already recording prior to the input of **Special Function**, then the Duration of the record will be set to zero (i.e. the record will be reset).



3.19. Preset Time

The **Preset Time** function may be used to set a measurement period in advance. This period may range from 1 second up to 100 hours (99 h 59 min 59 s). At the end of the measurement period, the current record is closed with all the relevant data, the next record is opened and a new measurement is started.

Checking and Changing the Preset Time:



Checking:

1. Set **Load/Run** to **Run**.
2. Press **Preset Time**.
   The display shows the current **Preset Time** in hours and minutes (hh:mm).
3. While keeping **Preset Time** depressed, press **s**.
   The display shows the current seconds part (ss) of **Preset Time**.

Changing:

1. Set **Load/Run** to **Load**.
2. Press and release **Preset Time**.
   The display shows 00:00 (hh:mm).
3. Use keys **0** to **9** to key-in hours and minutes of the **Preset Time**.
   When the digits are keyed-in, the digits are shifted along the display from right to left, thereby allowing corrections to be made.
4. Press and hold **s**.
   The display shows 00 (ss).
5. Use keys **0** to **9** to key-in seconds part of **Preset Time**.
6. Set **Load/Run** to **Run**.

3.19. Preset Time

Note:

1. Checking the status of the **Preset Time** does not interrupt nor affect the measurement in progress.
2. If, for example, 65 minutes is keyed-in, the entry will be corrected to 1 hour 5 minutes on switching to **Run**.
3. Changing the status of **Preset Time** resets the current record.

3.20. Interfacing the Sound Level Meter

3.20.1. The Monitor Program

All communication via Interface Module ZI9101 takes place under the control of the Monitor Program. This is partly stored in the operating system of the sound level meter, and partly loaded from the human-vibration module. The Monitor Program is used for:

1. sending data to a printer,
2. external control of the sound level meter.

Control of the sound level meter over the interface requires a terminal or personal computer with a compatible interface. The sound level meter transmits data through a Brüel & Kjær Serial Interface, which is structured close to RS–232–C. The built-in monitor has a limited set of commands, but full control of most instrument settings is possible.

The Monitor Program can operate at a variable baud rate (with or without echo) which can be read from the connected interface module. For more information about the interface see section 5.4 - Interface Module ZI9101.

The normal method of establishing control of the sound level meter, from the Monitor Program is achieved as follows:

1. Connect a terminal/personal computer to the sound level meter via Interface Module ZI9101 (if using equipment with an RS–232–C Interface, see Appendix D - Connection to RS–232–C Equipment).
2. Set the terminal and the interface module to the same baud rate and set the echo function as required (factory-set to 1200 without echo). If the terminal is used in full-duplex mode, then the echo function of the interface module should be on, so that data sent to the sound level meter is also sent back to the terminal screen. For half-duplex operation, the echo should be off. Set the terminal's "CAPS LOCK"-key to "on" (lower case commands are not accepted).

3.20. Interfacing the Sound Level Meter

3. Set the **Load/Run** switch to **Load**.
4. Press and release **Module No. 6**. (The display now shows M-Mo).
5. Set the **Load/Run** switch to **Run**.

The Monitor now transmits:

```
2231 MONITOR [Bel] [Bel] [Bel]
[Bel] [Bel] [Bel] [Bel] [Bel]
[CR] [LF]
: [CR]
```

where [CR] and [LF] indicate the Carriage Return and Line Feed characters respectively. Whenever the Monitor is ready to receive commands, it sends the prompt : [CR]. If control is from a terminal, the Prompt character ":" will be displayed on the screen. In the case of a personal computer, the program should check for this character to be received, followed by the Carriage Return character, [CR].

With Interface Module ZI9101 attached, there are two other methods of achieving control via the Monitor Program:

1. By maintaining the signal input (Received Data) to the interface module at high level while the sound level meter is switched on.
2. By maintaining the signal input to the interface module at high level while the **Reset** key is depressed.

The second method is intended for prospective future applications. For details of pin connections, refer to section 5.5 - Interface Specifications.

Control of the sound level meter through the Monitor Program stops when the Run (R) or the Run Continue (RC) commands are executed. Control can be regained as described above.

3.20. Interfacing the Sound Level Meter

3.20.2. Monitor Commands

The following commands are used to control the sound level meter and human-vibration unit via the Monitor Program:

R (Run)	Starts program execution from the start of a record and returns control of the sound level meter to its keypad.
RC (Run Continue)	Measurement already in progress is continued and returns control of the sound level meter to its keypad.
SH (Show Set-up)	Reads out the memory locations containing the sound level meter set-up codes. Each memory location contains 8-bit binary information which is represented in the readout by a 2-digit hexadecimal code.
SE (Set-up)	Allows alteration of the sound level meter set-up codes. The meaning of these codes and the method of changing them are explained in section 3.20.3 - Set-up Codes and section 3.20.4 - Alteration of Set-up Parameters respectively. After sending SE, the Monitor Program responds with: `> [CR]` Sending codes for new parameters may now take place.
P (Print)	Reads out the event data stored. After sending P, the Monitor Program responds with: `> [CR]` Sending codes for data transference to a terminal/personal computer for printout may now take place.

Note: Only commands in capital letters are accepted.

3.20. Interfacing the Sound Level Meter

3.20.3. Set-up Codes

Before the sound level meter can begin a measurement, all measurement parameters, such as **Time Constant, Mode, Special Function** and so on, must be set. These parameters are set to default values when the program is loaded from Human-vibration Module BZ7105. They are then stored in memory by the sound level meter in the form of numerical information known as set-up codes. Table 3.4 (a and b) lists each code together with its function.

The user can set the measurement parameters from the front panel of the sound level meter, as described in earlier sections of Chapter 3 - Operating Instructions. Alternatively, the Set-up Codes can be changed directly using the monitor command "SE" (Set-up). This method is described in section 3.20.4 - Alteration of Set-up Parameters.

An example of a set-up parameter read-out in hexadecimal code is:

```
5E00 0100 0000 1200 0000 0000 0000 0100 0000;
5E10 0000 0001 0000
```

The first four characters on each line are the two start addresses for the parameter fields following them. They are displayed automatically and cannot be changed.

3.20. Interfacing the Sound Level Meter

Address	Function	Value	Effect
5E00	Measurement Range	00 01	High Low
5E01	Detector Time Constant	00 01	1/8 second 1 second
5E02	Frequency Weighting	00 01 02 03 04 05 06	"HA: WT" "HA: LT" "WB: WT" "WB: LT" "WB: CW" "HA: WM" "HA: LM"
5E03	—	—	Not used
5E04	Special Function	12	Text code for "F" Should not be changed
5E05	Special Function (1st Digit)	00 to 09	0XX to 9XX
5E06	Special Function (2nd Digit)	00 to 09	XOX to X9X
5E07	Special Function (3rd Digit)	00 to 09	XX0 to XX9
5E08	—	—	Not used
5E09	—	—	Not used
5E0A	—	—	Not used
5E0B	—	—	Not used
5E0C	Unit	00 01 02	dB ms^{-2} K

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Table 3.4a. Set-Up Codes for Human-vibration Module BZ 7105

3.20. Interfacing the Sound Level Meter

Address	Function	Value	Effect
5E0D	—	—	Not used
5E0E	—	—	Not used
5E0F	—	—	Not used
5E10	Preset Time (Tens Hours)	00 to 09	0X to 9X
5E11	Preset Time (Units hours)	00 to 09	X0 to X9
5E12	Preset Time (Tens Minutes)	00 to 09	0X to 9X
5E13	Preset Time (Units Minutes)	00 to 09	X0 to X9
5E14	Preset Time (Tens Seconds)	00 to 09	0X to 9X
5E15	Preset Time (Units Seconds)	00 to 09	X0 to X9

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Table 3.4b. Set-Up Codes for Human-vibration Module BZ 7105 (Continued)

3.20. Interfacing the Sound Level Meter

3.20.4. Alteration of Set-up Parameters

To remotely change the set-up codes of the sound level meter, a sequence of commands and prompts is used. When using a terminal, the prompt characters appear on the screen, and the user keys in the commands. In the case of a computer, the program should automatically check for the prompts and transmit the commands.

The sequence of operations is:

`: [CR]`	"Prompt" character transmitted from the Monitor Program to indicate that it is ready to accept commands.
`SE [CR]`	"Set-Up" command transmitted to the Monitor Program to prepare it for parameter changes.
`> [CR]`	"Prompt" character transmitted from the Monitor Program to indicate that it is ready to accept the set-up codes.
`5E03 01 [CR]`	Example of a character string transmitted to the Monitor Program to change a required parameter (see actual examples below).
`: [CR]`	"Prompt" character transmitted from the Monitor Program to indicate that it is ready to accept further commands.

Examples:

1. Changes Mode to HA:WM:

```
:SE [CR]
>5E02 05 [CR]
:
```

2. Changes several parameters at one time (i.e. **Range** to "High" and **Time Constant** to 1s):

```
:SE [CR]
>5E00 00;5E01 01 [CR]
:
```

3. If changing two or more codes having consecutive addresses, then only the first address need be entered, as shown below.

```
:SE [CR]
>5E01 0205 [CR]
:
```

4. "." inserted one or more times between the keyed-in parameter values increments the parameter address a corresponding number of times. For example, after changing the parameter at address 5E01, address 5E06 is accessed by inserting "...." after the new parameter at address 5E01. If ";" is keyed-in after a parameter value, the next code to be entered is interpreted as an address.

```
:SE [CR]
>5E00_00.03;5E13_01 [CR]
:
```

changes the **Range** (address 5E00) to "High", **Mode** (address 5E02) to "WB:LT" (code 03) and **Preset Time** (address 5E13) to 1 minute (code 01).

The result of keying-in operations can be checked using the SH (i.e. Show Set-up) command as shown in section 3.20.3 - Set-up Codes.

3.20. Interfacing the Sound Level Meter

3.20.5. Print

To output the data stored in a specific record and in a specific digital output format, a short sequence of commands and prompts is used. When using a terminal, the prompt characters appear on the screen, and the user keys in the commands. In the case of a computer, the program should automatically check for the prompts and transmit the commands.

`: [CR]`	"Prompt" character transmitted from the Monitor Program to indicate that it is ready to accept commands.
`P [CR]`	"Set-Up" command transmitted to the Monitor to prepare it for printout.
`> [CR]`	"Prompt" character transmitted from the Monitor Program to indicate that it is ready to accept the desired print format and record.
`1 04 [CR]`	Example of a character string transmitted to the Monitor Program to print the required record (04) in the required print format (1).
`: [CR]`	"Prompt" character transmitted from the Monitor to indicate that the Monitor is ready to accept further commands.

3.20. Interfacing the Sound Level Meter

3.20.6. Error Messages

The Monitor reacts to syntax errors with the message `: S-ERR` and clears the input for corrected data to be keyed-in. However, there is NO check for errors incurred by keying-in values which lie outside the permissible ranges. Therefore, if control is via a computer program, the program must perform these checks. In some circumstances keying-in can be aborted using CTR-C (control-C):

```
:SET "CTR-C"
:

:SHOW "CTR-C"
:

:SET [CR]
> "CTR-C"
:
```

3.21. Display Symbols

U_ _ _

Underrange:
The level of signal reaching the sound level meter is below the current measuring range. Set Range accordingly.

O‾ ‾ ‾

Overrange:
The level of signal reaching the sound level meter is above the current measuring range. Set Range accordingly.

NA

Not Applicable:
The requested parameter is outside the allowed range. For example, selection of "Sum" Channel whilst in "HA:WM" Mode.

↑

Overload occurring:
The level of signal reaching the human-vibration unit is too high and is overloading the instrument's circuits.

▲

Overload has occurred:
The instrument's circuits have been overloaded during the measurement (i.e. since the last activation of **Reset Record**).

BAT

Battery Low:
Flashing "BAT" appears in the display. Replace batteries.

3.21. Display Symbols

M-E1

No Application Module inserted:
This message will appear if **Load** is selected when there is no application software stored in the sound level meter memory and no application module inserted.

M-E2

Application Module software not yet stored:
There is no application software stored in the sound level meter memory.

M-E3

Error in software copy:
The application software stored in the sound level meter contains an error. Reload with the appropriate application module.

M---

Ready to load Module firmware:
If there is no application software stored in the sound level meter memory, this message appears when the sound level meter is ready to load software from the inserted application module.

M- 6

Application Module number:
The identifying number of the application software is shown at the end of a successful loading, or by pressing **Module No. 6** when **Run** is selected.

M-Mo

Monitor:
This message indicates that the Monitor Program is enabled and the sound level meter is set up to communicate across the interface.

Chapter 4

Human-vibration Module BZ7105 User Guide

4. User Guide

This chapter outlines the basic step-by-step procedure for making a simple human-vibration measurement with Modular Precision Sound Level Meter Type 2231, Human-vibration Module BZ7105 and Human-vibration Unit Type 2522. In the measurement example given, the vibration transmitted to the operator of an industrial power drill through one of the handles is investigated. The measurement set-up is shown in Fig. 4.1.

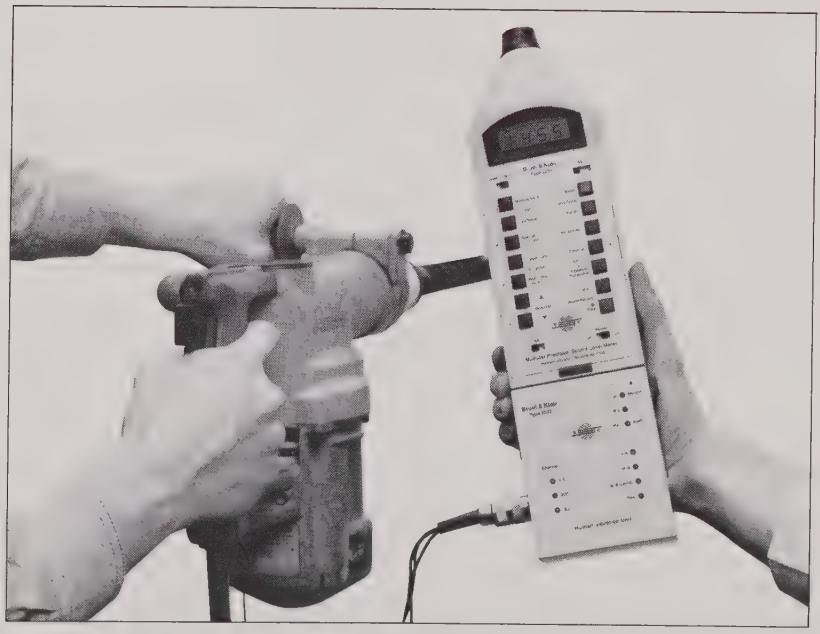

Fig. 4.1. Typical set-up for the measurement of vibration transmitted to the hand from the rear handle of an industrial drill

4. User Guide

Procedure Check-list

Below is a check-list for the procedure for one particular series of measurements. For more detailed information about connections, checks and control functions used for the measurement, see Chapter 2 - Setting up the 2231 Sound Level Meter and Chapter 3 - User Instructions.

SLM Connections	1. Mount the human-vibration unit onto the sound level meter.
	2. Connect the input adaptor to the human-vibration unit.
	3. Ensure that the Socket Cap YJ0217 is in place on the sound level meter.
	4. Insert the human-vibration module and attach the corresponding front plate.
	5. Switch the power of the sound level meter on.
	6. Load the human-vibration module.
SLM Test and Checks	7. Test the sound level meter display (this checks that correct and functioning batteries are installed in both the sound level meter and the human-vibration unit.
	8. Set the Real Time Clock.
	9. Check the sensitivity of the human-vibration unit (see Note) with the accelerometer to be used.
Vibration Adaptor Connections	10. Connect Hand-Arm Vibration Set Type 4392 to Channel 2 of Input Adaptor AO0312. For the measurement of the vibration transmitted through the right hand of the operator, use Handle Adaptor UA0894. In this case, only the perpendicular axis will be considered so attach one Accelerometer Type 4374 in the perpendicular mounting hole as described in the Instruction Manual for the vibration set.

Control Settings

11. Set **Mode** to HA:WM.
12. Set **Time Constant** to 1 s.
13. Set **Range** to HIGH.
14. Set **Channel** to 2.
15. Set **Unit** to m/s^{h}.
16. Set **Displayed Parameter** to AEQ.
17. Set **Preset Time** to, for example, 2 minutes.
18. Set **Special Function** to F100 for automatic data storage.

Start Measurement

19. Press **Reset Record** to start the measurement. After every 2 minutes, the relevant data will be stored in a record and a new measurement started in the next one.

Stop Measurement

20. When desired, press **Stop** to terminate the measurement series.

The data recorded during the measurement series can now be printed out on, for example, Graphics Printer Type 2318.

Note:
With a Uni-Gain® accelerometer, step 9 need not be followed, due to the calibrated sensitivity of this type of accelerometer (see section 2.7 - Checking Sensitivity). Of the recommended accelerometers only Accelerometer Type 4374 may need a sensitivity check.

Chapter 5

Use with Other Equipment

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5. Use with other Equipment

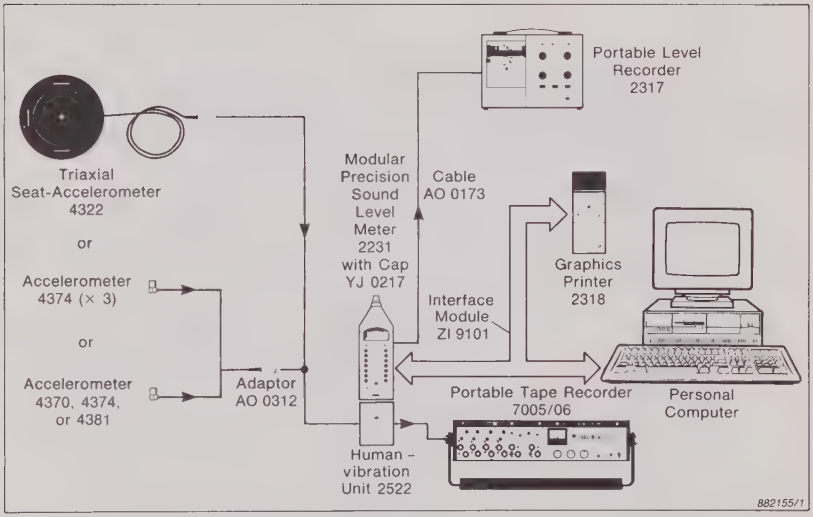

Fig. 5.1. Optional measuring and recording equipment for use with Modular Precision Sound Level Meter Type 2231 and Human-vibration Unit Type 2522 after loading of Human-vibration Module BZ 7105

Fig. 5.1 shows the connections for measuring and recording human-vibration after loading of Human-vibration Module BZ7105. The recording and documentation equipment shown are described in the relevant sections in this chapter.

5.1. Portable Level Recorder Type 2317

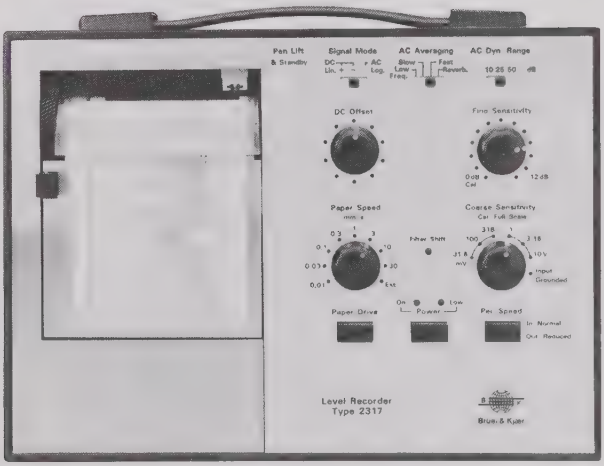

Fig.5.2. Portable Level Recorder Type 2317

5.1.1. Introduction

Normally, two signal outputs (AC and DC) are available for level recording from the sound level meter. When being used with the human-vibration module, however, only the DC Output is available since the AC Output of the sound level meter is bypassed (see Appendix A - Instrument Characteristics).

The DC output from the sound level meter is an analogue version of what is shown on the digital portion of the display, as selected by the **Displayed Parameter**. However, the DC Output does not include any correction for the Range status. A 3 V output corresponds to the top limit of the selected Range and decreases at 50 mV/dB. Therefore, if both the "High" and the "Low" Range are going to be used for the comparison of different signals, an appropriate adjustment needs to be made on the Portable Level Recorder Type 2317 when changing the Range status.

5.1. Portable Level Recorder Type 2317

As with the digital display, the DC output signal is updated once per second. The result is a "stepped" recording (see Fig. 5.4) which gives a clear, well-defined indication of the level of each parameter that can be shown on the display.

A disadvantage of the recording is that it does not follow faithfully the true RMS fluctuations. For this purpose, there are three AC outputs from the human-vibration unit, one for each measurement channel, which can be used to record the vibration signal in each axis. The outputs are frequency weighted according to the **Mode** but are independent of the **Time Constant** (see Appendix A - Instrument Characteristics).

Examples of recordings made with the sound level meter and human-vibration module with the level recorder are shown in Figs. 5.3 to 5.5.

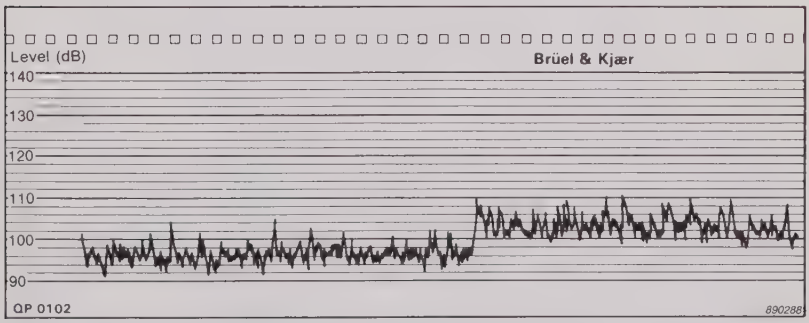

Fig. 5.3. AC recording of a typical (whole-body) vibration signal taken from the human-vibration module. The Mode of the human-vibration module is set to "WB:LT", the Range to "Low" and the Channel to "Z". The status of Displayed Parameter and Time Constant have no effect on this output. The Paper Speed of the Level Recorder is set to 3 mm/s

5.1. Portable Level Recorder Type 2317

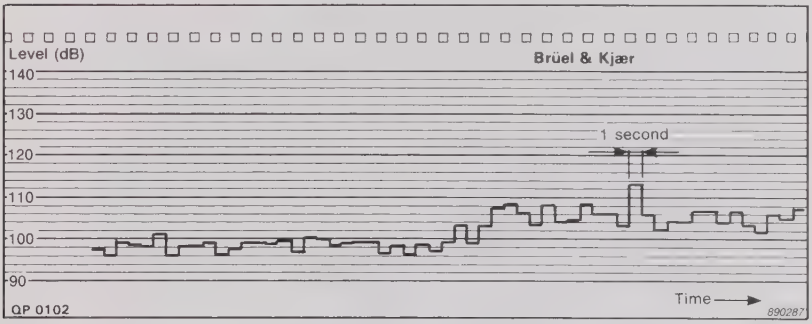

Fig. 5.4. DC recording of the same vibration signal taken from the sound level meter. The Time Constant of the human-vibration module is set to "1/8s", the Mode to "WB:LT", the Range to "Low", the Channel to "Z" and the Displayed Parameter to "INST". Note how the recorded signal is stepped in appearance. This is due to the fact that the DC output of the sound level meter is updated only once per second with the sampled acceleration level measured at the end of the previous sample period (1 second)

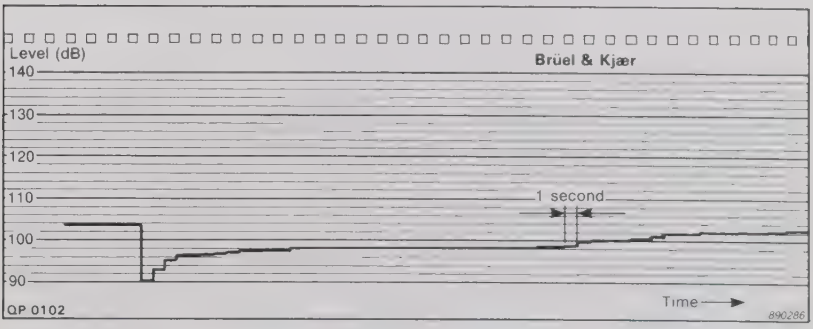

Fig. 5.5. DC recording of the same vibration signal taken from the sound level meter. The Time Constant of the human-vibration module is set to "1/8s", the Mode to "HA:LM", the Range to "Low", the Channel to "Z" and the Displayed Parameter to "AEQ". The fluctuations of the recorded signal are minimal due to the integration of the vibration signal over the measurement period

5.1. Portable Level Recorder Type 2317

5.1.2. Calibration

DC Recording:

1. Set **Load/Run** to **Load**.
2. Set **Special Function** to F800 as in section 3.17 - Special Functions.
3. Set **Load/Run** back to **Run**. The DC Output voltage will now alternate between 0 and 2,5 V at 1 second intervals.
4. Set the level recorder to its "1 V", "DC-Lin" range and adjust the **Fine Sensitivity** and **DC Offset** controls to give a deflection of 0 to 50 dB (With 50 dB division of the recording paper, only the bottom part of the normal dynamic range will be used. If a range greater than 50 dB is desired, adjust the sensitivity of the recorder so that the 0 to 50 dB deflection is correspondingly smaller).

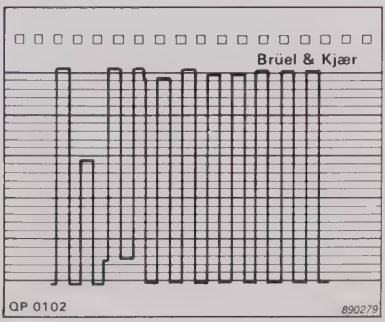

Fig. 5.6. DC output voltage alternates between 0 and 2,5 V (0 to 50 dB) when the sound level meter Special Function is set to "F800"

5. Using the **DC Offset** control on the level recorder, adjust the pen so that the upper limit of the deflection lies 10 dB below the top of the recording paper.
6. Use the **Range** plus the **Selector ▲** or **Selector ▼** keys to set the appropriate measuring range. The uppermost line on the recording paper corresponds to the upper limit of the selected **Range**.

AC Recording:

1. Set the level recorder to its "10 V", "AC-Log", "50 dB" range with "Slow" (1 s) weighting.
2. Set **Fine Sensitivity** to "0 dB Cal.".
3. Set up the sound level meter, human-vibration module and calibration exciter for a sensitivity check and start the sensitivity check procedure for one channel (see section 2.7 - Checking Sensitivity).
4. Using the **Fine Sensitivity** control on the level recorder, adjust the pen for a conveniently placed reference level.

5.1. Portable Level Recorder Type 2317

5.1.3. Recording Procedure

1. For DC recordings, connect the DC Output of the sound level meter to the level recorder using Cable AO 0173. For AC recordings, connect one of the AC Output channels of the human-vibration unit to the level recorder using the same type of cable.
2. Set the controls on the level recorder as follows:

Signal Mode	: "DC Lin +"
Coarse Sensitivity	: "1 V"
Paper Drive	: Out
Paper Speed	: "3 mm/s"
Pen Speed	: "Normal"
Pen Lift	: In
Power	: On

3. Set up the sound level meter for measurement.
4. Press **Paper Drive** and release **Pen Lift**.
5. Press **Start** on the sound level meter press to start measurements and recording.
6. Press **Paper Drive** and **Pen Lift** to stop recording on paper.

5.2. Graphics Printer Type 2318

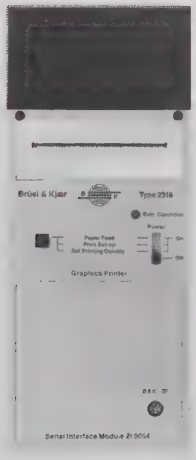

Fig. 5.7. Graphics Printer Type 2318

Graphics Printer Type 2318 is a thermal dot-matrix printer for documenting measurement results stored in the memory of the sound level meter. Measurement results are output digitally through Interface Module ZI9101 to this or any compatible printer. Five print formats are available for the documentation (see section 3.17 - Special Functions). For a full description of the print formats see section 3.17.4 - Printout Formats.

Note: Both the graphics printer and the interface module have variable baud rate settings. Consult the Instruction Manual for Graphics Printer Type 2318 and section 5.4 - Interface Module ZI9101 of this Manual for details on how to check, and where necessary, change the Baud rate so it is the same for both.

5.2. Graphics Printer Type 2318

To obtain a printout of stored results:

1. Switch off the graphics printer and the sound level meter.
2. Fit Interface Module ZI9101 to the sound level meter (it fits in the same way as the human-vibration module).
3. Insert the 5-pin LEMO plug of the interface module into the B&K-SI socket on the graphics printer making sure that the red dots are lined up.
4. Switch on the graphics printer and the sound level meter.
5. Select a print format using **Special Function** (see section 3.17 - Special Functions). The printout starts immediately after the print format has been selected.

5.3. Tape Recorder Type 7005/06

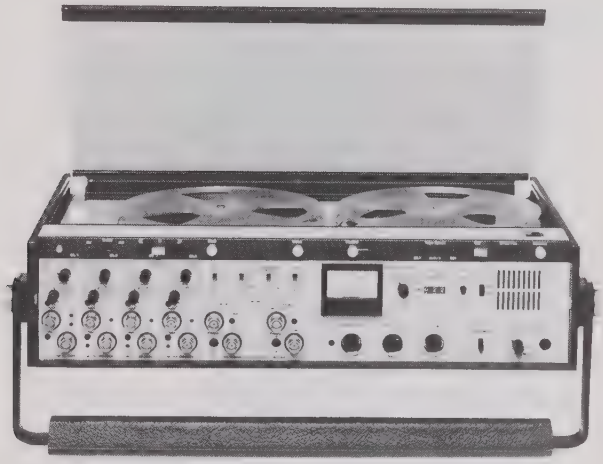

Fig. 5.8. Tape Recorder Type 7005/06

For some applications, the user may wish to record the vibration signals entering the three channels of the human-vibration unit. This is particularly relevant where future analysis of field data is required using laboratory equipment (e.g. 1/3-octave frequency analysis using Real-time Frequency Analyzer Type 2123). Tape Recorder Type 7005/06 is ideally suited to the task due to its ability to record all three channels simultaneously.

5.3. Tape Recorder Type 7005/06

To set up Tape Recorder Type 7005/06, proceed as follows:

1. Calibrate the FM and/or Direct record/reproduce channels of the tape recorder and check the sensitivity of of the sound level meter.

2. Connect the three **AC Output** sockets of the human-vibration unit to the **Input** sockets of the FM or Direct record/reproduce channels chosen. Use three Cables AO 0173 if a triaxial mode is being employed. Otherwise, connect the **Channel 2 (Y) AC Output** of the unit to the relevant **Input** socket as described above.

3. Set the sound level meter as required for the measurement, as in the example below:

Power	: "On"
Load/Run	: "Run"
Mode	: "HA:LT"
Time Constant	: 1/8 s
Displayed Parameter	: "INST"

The status of **Channel** of the sound level meter has no relevance (see Appendix A – Instrument Characteristics).

5.3. Tape Recorder Type 7005/06

4. Set the controls of the recording channel of the tape recorder as follows:

Mode Switch	: "AC"
Input Attenuator	: "30 dB" (i.e. 1 V)
Meter-Monitor Switch	: to any corresponding channel

Make sure the **Input Switch** on the Compander Unit is set to the "Off" position.

With the tape recorder calibrated as above, the "0 dB nominal record/reproduce" level will always correspond to the top of the Range selected. Provided that an indicating instrument with 1 V RMS range is chosen for measurement of the recorded signal on playback, then full scale meter deflection on playback will correspond to the top of the Range chosen for recording the original signal.

Prior to recording measurements it is recommended that the reference used for calibrating the sound level Meter is recorded on tape. On playback this will allow accurate adjustment of the Sens. Adj. potentiometer of the indicating instrument to compensate for small differences between the recorded and reproduced signal amplitudes.

For a more complete explanation about recording, including details about the record/reproduce characteristics of the FM and Direct record/reproduce channels of the tape recorder, please consult the Instruction Manual for the tape recorder.

5.4. Interface Module ZI9101

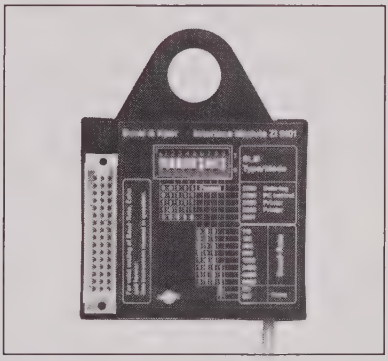

Fig. 5.9. Interface Module ZI9101, showing the baud rate multi-switch and switch settings

5.4.1. General

Interface Module ZI9101 allows communication between the sound level meter and other digital devices. It conforms to the Brüel & Kjær Serial Interface Standard (B & K–SI), and connects to the sound level meter in the same way as Human-vibration Module BZ7105.

The interface is fitted with a 5-pin LEMO plug, and is intended for use with Graphics Printer Type 2318 and other compatible printers (see section 3.17 - Special Functions). Connection to a terminal or microcomputer for remote control of the sound level meter instrument settings is also possible (see section 3.20 - Interfacing the Sound Level Meter). A supplied Adaptor AO0335 enables the interface to link up to a female 25-pin D-type connector, which is common for equipment having an RS–232–C or V24 Interface.

WARNING! It is essential to switch off power to the sound level meter and all other instruments before connecting the interface module. Otherwise electrical damage to the instruments could result.

5.4. Interface Module ZI9101

5.4.2. Baud Rate Settings

The baud rate of the interface module is factory set to 1200 baud without echo. For ease of setting, a small multi-switch is mounted on the rear of the module, as shown in Fig. 5.10, with the key to the baud rate settings also printed on the rear. The switch settings are also listed in Table 5.1.

		SWITCH								
		1	2	3	4	5	6	7	8	9
SLM Type/ Mode	2230 Data-log	0	0	1	1	1	FORMAT			
	2230 PC control	0	1	1	1	1				
	2230 Printer	1	1	1	1	1				
	2233 Printer	1	0	1	1	1				
	2231	0	0	0	0	0				
Baud Rate	110						0	0	0	
	150						0	0	1	
	300						0	1	0	
	600						0	1	1	
	600						0	1	1	
	1200						1	0	0	
	2400						1	0	1	1
	4800						1	1	0	1
	9600						1	1	1	1
Echo	On									0
	Off									1

T02-...GB0

Table 5.1. Interface Module ZI9101 switch settings

5.4. Interface Module ZI9101

5.4.3. Interface Specifications

The B & K–SI is structured close to EIA Standard RS–232–C (equivalent to CCITT V24) and, when fitted with the interface module, the sound level meter can communicate with almost any equipment whose interface conforms to these standards (see Appendix D - Connection to RS–232–C Equipment). The main difference between B & K–SI and RS–232–C is that the B&K interface uses lower signal voltage levels, to reduce power consumption.

The following specifications apply to the B&K Serial Interface:

1 Start Bit
8 Data Bits
1 Stop Bit
No Parity Bit
Baud Rate: Adjustable

	B&K – SI	RS–232–C
Connector	5 Pin LEMO (ZI 9101) or 25 Pin "D"–Type (ZI 9101 with AO 0335)	Not specified. 25 Pin "D" – Type generally used
Signal Voltage Level (Open-circuit Load)	±5 V (Nominal)	±12 V (Nominal)
(Max. Load)	Min. at Sender ±2 V Min. at Receiver ±1 V	Min. at Sender ±5 V Min. at Receiver ±3 V

T02022GB0

Table 5.2. B & K–SI and RS–232–C comparisons

5.4. Interface Module ZI 9101

Mnemonic	Signal Name (B & K – SI)	Pin No. (ZI 9101)	Pin No. (ZI 9101 with AO 0335)
EXTC	Externals Connected	1	5 + 6 + 8
HS	Handshake	2	20
TD	Transmitted Data	3	3
SG	Signal Ground	4	7
RD	Received Data	5	2
PG	Protective Ground	Screen	1

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Table 5.3. Pin connections

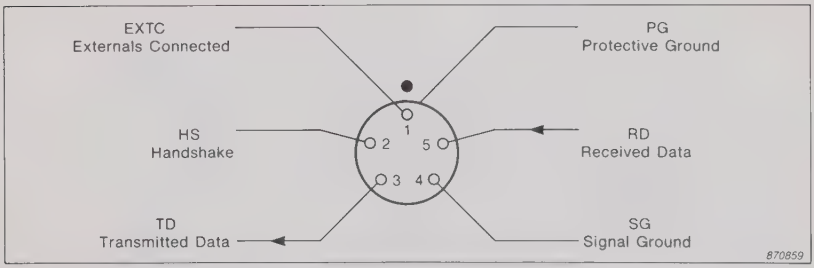

Fig. 5.10. Pin designations of the 5-pin LEMO plug on Interface Module ZI 9101 (viewed from solder side)

Chapter 6

Care and Maintenance

6. Care and Maintenance

Hints for Trouble-free Use:

- Never attach an accelerometer with the instrument power on.
- Apply only light finger torque to the accelerometer, extension cables, adaptor etc.
- Ensure that cables between the accelerometers and the human-vibration unit are firmly anchored to avoid noise from the cables. Take special care of possible movement at the plugs of the cables.
- If low levels of vibration are being measured or if vibration is to be measured over a long period of time, mount the human-vibration unit on a tripod or other steady support to prevent undue cable motion.
- Keep protective covers on all sockets and interfaces when not in use to prevent dirt and static build-up.
- Avoid exposure of the instrument and accessories to excessive damp, cold, and heat.
- Ensure that the batteries are maintained in good condition. Leaking batteries may damage the instruments.
- Keep the instrument stored in a dry environment, preferably in the special carrying case (B&K order No. KE0226).

Note: For further information on securing accelerometer cables consult the Brüel&Kjær handbook "Piezoelectric Accelerometers and Vibration Preamplifiers" (BB 0694-12).

6. Care and Maintenance

Service and Repair:

The Modular Precision Sound Level Meter Type 2231 and Human-vibration Unit Type 2522 are designed and constructed to provide the user with many years of reliable operation. However, should a fault occur which impairs correct functioning, then the internal batteries should be removed to prevent risk of further damage. For repair contact your local Brüel & Kjær service representative. Under no circumstances should repair be attempted by persons not qualified in the service of B & K instrumentation.

Chapter 7

Specifications

7. Specifications

MEASUREMENT MODES:
Measuring set complies with ISO/DIS 8041. The measurement modes are as specified below:
HA:LT: Hand-Arm triaxial mode with linear frequency weighting (8-1000 Hz)
HA:WT: Hand-Arm triaxial mode with frequency weighting (8-1000 Hz) complying with ISO 5349
HA:LM: Hand-Arm monaxial mode with linear frequency weighting (8-1000 Hz)
HA:WM: Hand-Arm monaxial mode with frequency weighting (8-1000 Hz) complying with ISO 5349
WB:LT: Whole-Body triaxial mode with linear frequency weighting (1-80 Hz)
WB:WT: Whole-Body triaxial mode with frequency weighting (1-80 Hz) complying with ISO 2631/1
WB:CW: Whole-Body Combined monaxial mode with frequency weighting (1-80 Hz) complying with ISO 2631/2
Ranges: As defined in the table below (those marked * are frequency dependent – see Appendix A – Instrument Characteristics):

	ms^{-2}	dB	K
H–A (Weighted)	1,000 – 1000 0,316 – 1000	120 – 180* 110 – 160	6,250 – 6250 1,975 – 625,0
H–A (Linear)	10,0 – 10000 1,000 – 1000	140 – 200 120 – 180	
W–B (Weighted)	0,100 – 100,0 0,020 – 10,00	100 – 160* 86 – 140	2,860 – 2860 0,572 – 286,0
W–B (Linear)	1,000 – 1000 0,100 – 100,0	120 – 180 100 – 160	
W–B Comb.	0,010 – 10,00 0,002 – 1,000	80 – 140* 66 – 120	0,286 – 286,0 0,0572 – 28,6

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MEASUREMENT UNITS:
ms^{-2}
K (as defined by DIN 45 671)
dB (ref $1 \mu ms^{-2}$)

DETECTOR TIME CONSTANT:
1/8 second
1 second

CALCULATED DATA:
Maximum Peak Value (channels X, Y, Z)
Max RMS Value (channels X, Y, Z)
Min RMS Value (channels X, Y, Z)
a_{eq} (channels X, Y, Z, "Sum")

RESET RECORD:
Causes Max./Min. detectors, a_{eq}, Start Time, Duration and overload detector to be reset

DATA STORE:
Organised consecutively in one of 99 numbered records. Every record is marked with Record Number, Start Time, Stop Time, Duration, Measurement Mode, Detector Time Constant, Measurement Unit, Overload detected plus all calculated data

REAL–TIME CLOCK:
Activated upon the loading of Human-vibration Module BZ7105

MULTIPLEXING:
All measuring channels (Peak and RMS) sampled 32 times every second

INPUT:
To 3 charge amplifiers through a 6-pin DIN socket on the side of the unit
Input Channel Separation: >60 dB
Input Sensitivity: Calibrated for accelerometer sensitivities:
Hand-Arm (H–A): 0.1 pC/ms^{-2} (Accelerometer Type 4374)
Whole-Body (W–B): 1 pC/ms^{-2} (Triaxial Seat-Accelerometer Type 4322)
Whole-Body Combined (W–B Comb.): 10 pC/ms^{-2} (single-axis Accelerometers Types 4370 and 4381)
Sensitivity Adjustment: –1 dB to +2,3 dB

OPERATION:
Via the SLM keypad or terminal/personal computer through Interface Module ZI9101

7. Specifications

ANALOG OUTPUTS:
Mini jack-socket
AC Output: Three: one from each channel of the human-vibration unit
Ouput Impedance: $<50\,\Omega$
Maximum Load: $5\,k\Omega$
DC Output: One (short circuit protected) from SLM corresponding to displayed parameter
Range: 0 to 3 V for full scale (5 V to indicate overload condition) at 50 mV/dB
Output impedance: $<100\,\Omega$

DIGITAL OUTPUT:
Interface Module ZI9101 for output to printer or terminal/personal computer

INTERFACE:
25-pin "D" connector
Open circuit signal level: ± 5 V
Minimum Send level: ± 2 V
Minimum Receive level: ± 1 V

PRINT FORMATS:
5 for Graphics Printer Type 2318. 3 for other compatible printers

ELECTROMAGNETIC COMPATIBILITY:
Complies with Class B of the American FCC (Federal Communications Commision) rules

ENVIRONMENTAL CONDITIONS:
Operating Temperature Range: –10 to +50°C (+14 to +122°F)
Storage without Batteries: –20 to +70°C (–4 to 158°F)
Maximum Humidity for Operation: 90% RH at +40°C
Maximum Humidity for Storage: 90-95% RH at +40°C for 96 hrs
Overload Limit: 1,41 × Full Scale Deflection (3 dB over Full Scale Deflection)
Maximum Input Levels:
H–A : 210 dB >2500 Hz
W–B : 190 dB >200 Hz
W–B Comb.: 170 dB >200 Hz

MEMORY CAPACITY:
4 Kbyte ROM for general routines, tables etc. 16 Kbyte RAM for application software and data storage

DISPLAY:
Digital: 4 digits, 14 segments, liquid crystal, 8 mm high, 0,1 dB resolution
Quasi-analogue: 60 dB scale with 2 dB resolution for monitoring current signal (RMS or Peak)
Additional functions: Overload Occurring, Overload has Occurred, Battery Near Low Level and Battery at Low Level

LOG PEAK DETECTOR:
Stores maximum peak level during measurement period
Rise time: $<100\,\mu s$
Dynamic Range: 63 dB

OVERALL DIMENSIONS AND WEIGHT:
Sound Level Meter: 370 × 85 × 47 mm (14,7 × 3,3 × 1,8 in)
1 kg (2,2 lb) with batteries
Human-vibration Unit: 105 × 85 × 47 mm (4,1 × 3,3 × 1,8 in)
450 g (1 lb) with batteries

BATTERIES:
Type: 8 × 1,5 V, LR6 or AA size cells (four in the meter, four in the unit)
Life: approx. 8 hours

ACCESSORIES INCLUDED with 2522:
4 × Alkaline Cells ..... QB 0013
Input Adaptor ..... AO 0312
Socket Cap ..... YJ 0217
Instruction Manual

ACCESSORIES AVAILABLE for 2522:
Modular Precision Sound Level Meter Type 2231
Human-vibration Module ..... BZ 7105
Portable Level Recorder ..... Type 2317
Graphics Printer ..... Type 2318
Triaxial Seat-Accelerometer ..... Type 4322
Hand-Arm Transducer Set ..... Type 4392
Tape Recorder ..... Types 7005/06
Cable ..... AO 0173
2,5 mm Mini-Jack Plug ..... JP 0213
Socket Screening Cap ..... YM 0420
Mains Power Supply and Charger ..... ZG 0254
Interface Module ..... ZI 9101
Recommended Accelerometers ..... Types 4370, 4374 and 4381

Appendices

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Appendix A: Instrument Characteristics

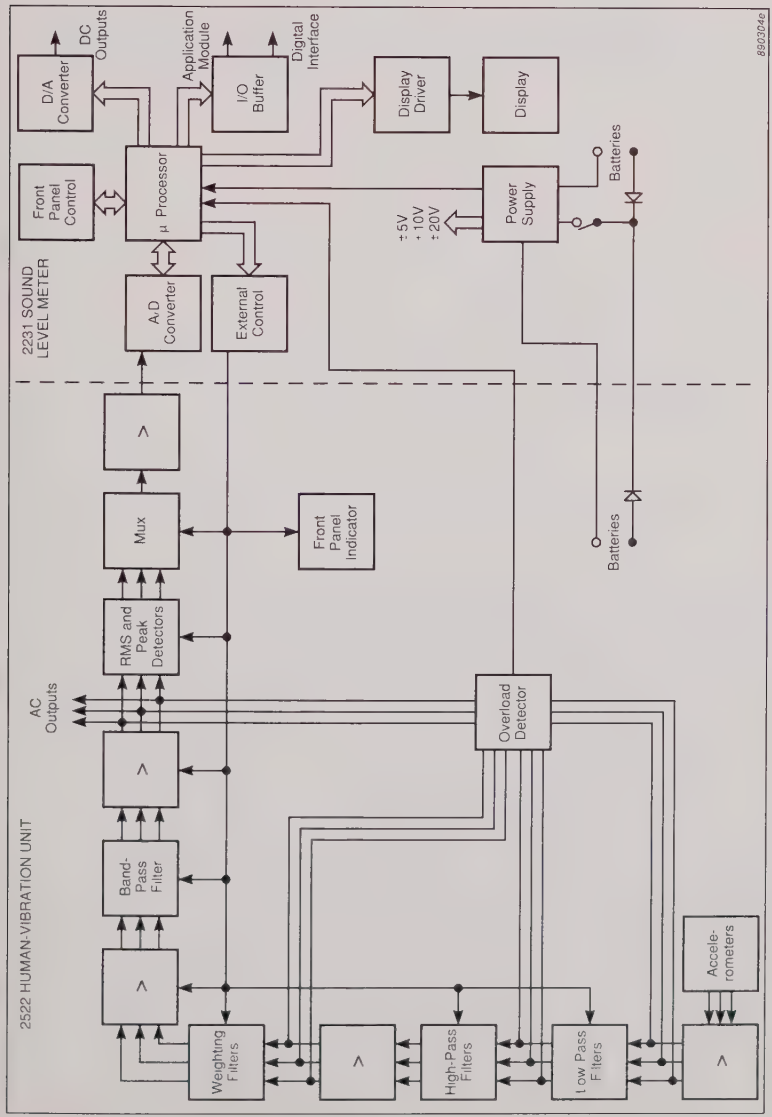

Fig. A.1. Sound level meter and human-vibration unit schematic circuit diagram

Appendix A:
Instrument Characteristics

Connection between the sound level meter and the human-vibration unit is via the 15-pin connector at the base of the sound level meter. The corresponding connector of the human-vibration unit is shown in Fig. A.2.

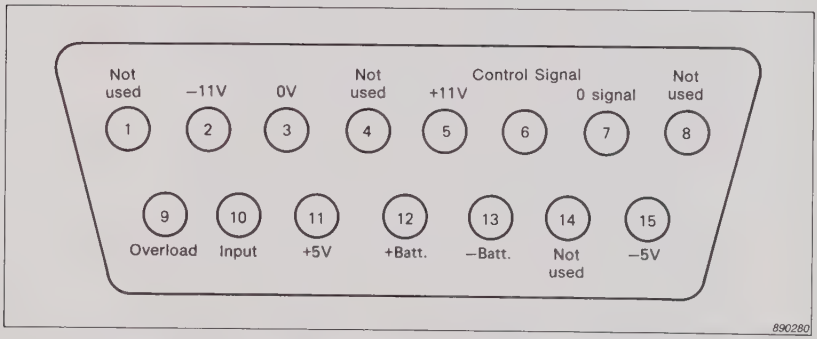

Fig. A.2. External view of the 15-pin connector of the human-vibration unit for connection to the sound level meter

Human-vibration Module BZ7105 contains software which controls the multiplexer of Human-vibration Unit Type 2522, thus enabling it to sample the LMS and Log|Peak| value from each input channel 32 times every second. The microprocessor of Modular Precision Sound Level Meter Type 2231 is used to store, transport and arithmetically manipulate the data sent to it from the human-vibration unit.

Human-vibration Unit Type 2522 also contains two "Reserved" functions (not shown in Fig. A.1) for use with future application modules.

Due to the method of overload detection, the upper limits of the "High" ranges in weighted modes are frequency dependent. The maximum input levels without overload for weighted modes in the "High" Range are shown in Fig. A.4.

Appendix A:
Instrument Characteristics

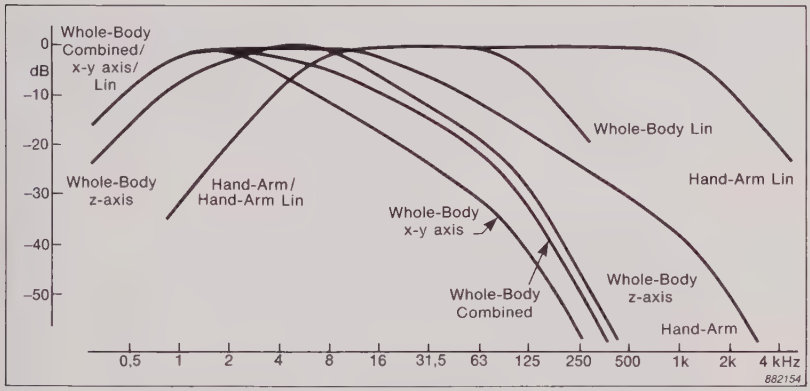

Fig. A.3. Response of the frequency weighting filters incorporated in the human-vibration unit

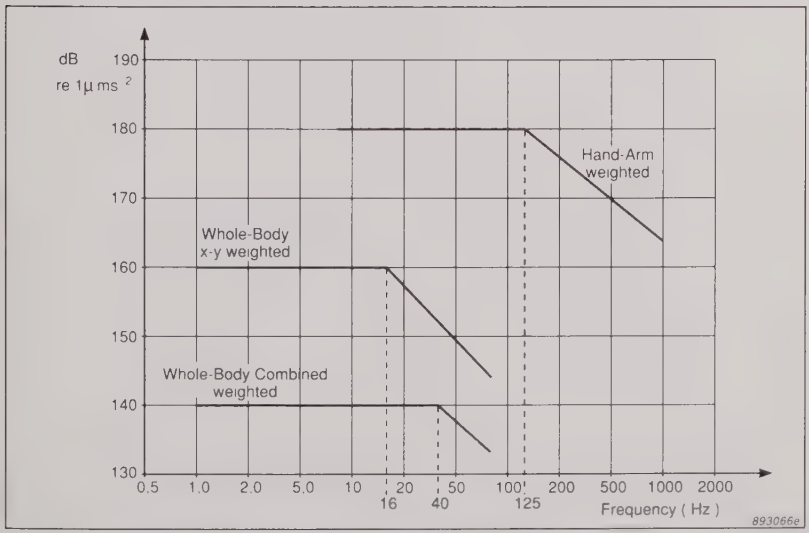

Fig. A.4. Maximum input levels without overload for weighted modes in the "High" Range

Appendix B: Recommended Accelerometers

The various measurement Modes which make up the measuring set have different sensitivities, as described in Chapter 7 - Specifications. As a result, the sound level meter and human-vibration unit are dedicated to different accelerometers for different purposes. The recommended Brüel & Kjær accelerometers to which the set is dedicated, and in what modes they are used, are listed below.

Triaxial Seat-Accelerometer Type 4322: Sensitivity 1 pC/ms^{-2}. Used with Whole-Body Modes. Comprises of a triaxial accelerometer in a nitrile rubber moulded cushion.

Accelerometer Type 4370: Sensitivity 10 pC/ms^{-2}. Used with the Whole-Body Combined Mode. Can be used in either temporary or permanent vibration measurement setups.

Accelerometer Type 4374 (contained in Hand-Arm Transducer Set Type 4392): Sensitivity 0,1 pC/ms^{-2}. Used with Hand-Arm Modes. Hand-Arm Transducer Set Type 4392 contains handle- and hand-adaptors for ease of hand-arm vibration measurements in up to three orthogonal axes at once.

Accelerometer Type 4381: Sensitivity 10 pC/ms^{-2}. Used with the Whole-Body Combined Mode. Can be used in either temporary or permanent vibration measurement setups.

Appendix C: Description of a_{eq}

a_{eq}

$a_{eq,T}$ is the acceleration level averaged over the measurement period T. It can be considered as the continuous steady state acceleration level which would have the same total energy as the real fluctuating vibrations over the same time period. The measurement of $a_{eq,T}$ is based on the equal energy principle:

Either:

$$a_{eq,T}(\text{dB}) = 10\ \text{Log}_{10}\frac{1}{T}\int_0^T\left(\frac{a_m(t)}{a_o}\right)^2\ \text{dt} \qquad \text{dB}$$

where a_o is the reference acceleration ($1\,\mu\text{ms}^{-2}$), $a_m(t)$ is the time varying acceleration (in ms^{-2}) and T is the time interval over which it is measured,

or:

$$a_{eq,T}(\text{ms}^{-2}) = \frac{1}{T}\int_0^T a_m(t)^2\ \text{dt} \qquad \text{ms}^{-2}$$

where $a_m(t)$ is the time varying acceleration (in ms^{-2}) and T is the time interval over which it is measured,

or:

$$a_{eq,T}(\text{K}) = \frac{1}{T}\int_0^T a_k(t)^2\ \text{dt} \qquad \text{K}$$

where $a_k(t)$ is the time varying acceleration (in K) and T is the time interval over which it is measured.

Appendix C: Description of a_{eq}

"Sum"

The a_{eq} "Sum" displayed by the sound level meter is not necessarily the exact sum of the three channel values but is dependent on the measurement unit and mode in use. It is defined in the relevant standards as below:

For Whole-Body measurements displayed in units of ms^{-2} or dB, the sum of the overall weighted acceleration values is defined as:

$$a = \sqrt{(1{,}4\, a_x)^2 + (1{,}4\, a_y)^2 + a_z^2}$$

where a = Sum of the weighted acceleration values,
a_i = Weighted acceleration value in the i-direction,
i = x, y, z.

For Whole-Body measurements displayed in units of K, and for all Hand-Arm measurements, the sum of the overall weighted acceleration values is defined as:

$$a = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

where the symbols have the same meanings.

The a_{eq} of the sum of the overall weighted acceleration values, as defined in the above equations, is then calculated by integration and averaging.

Note:
The units of K (as defined in DIN 45 671) contain frequency weighting functions which are also dependent on the axis of measurement. In Hand-Arm measurements, the weighting functions for each axis are equally sensitive, corresponding to the sensitivity of the human hand-arm system to vibration. In Whole-Body measurements, however, the weighting functions for the x- and y-axes are 1,4 times more sensitive than that for the z-axis, corresponding with the increase in sensitivity of the human body to vibrations in the x- and y-axes compared with that for vibrations in the z-axis. The frequency weighting functions, when using other measurement units, have equal sensitivity. These factors cause the need for the two definitions of "Sum".

Appendix D:
Connection to RS–232–C Equipment

The RS–232–C Standard was developed for connection of terminals (Data Terminal Equipment, DTE) to modems (Data Communications Equipment, DCE). Any equipment having an RS–232–C interface must conform to the standard for either DTE or DCE.

It is only possible to connect two devices directly if one conforms to the standard for DCE and the other to that for DTE, as shown in Fig. D.1.

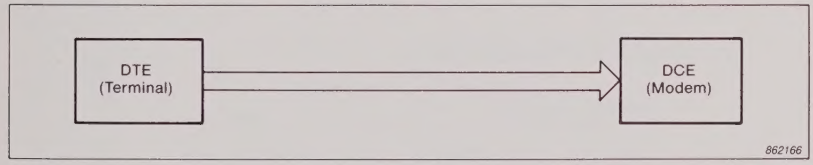

Fig. D.1. DTE (terminal)-DCE

Modular Precision Sound Level Meter Type 2231 functions as a DCE device, and when fitted with Interface Module ZI9101 it can be connected directly to DTE devices, such as terminals or microcomputers. For connection to DCE devices some pin connections must be interchanged. This is done either by using a custom-built cable, or a cross-connection unit, as shown in Fig.D.2.

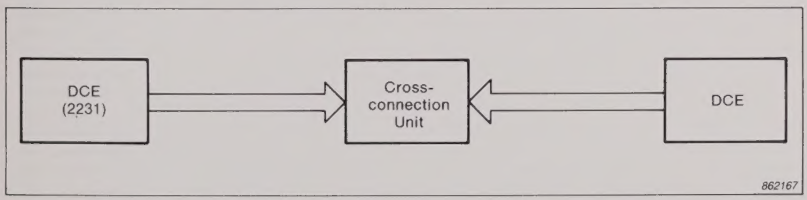

Fig. D.2. DCE (2231)-Cross connection-DCE

Appendix D:
Connection to RS–232–C Equipment

The connections of the cross-connection unit should be as shown in Fig. D.3.

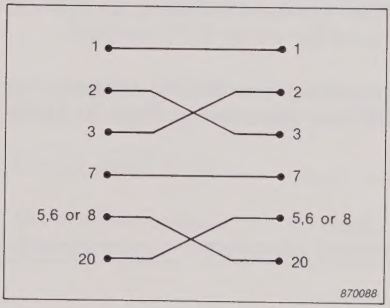

Fig. D.3. Connections in a cross-connection unit

For details of the pin connections of the Interface Module ZI9101 see section 5.4.3 - Interface Specifications.

Pushkey Directory

Note: The command initiated by some pushkeys depends upon whether the sound level meter is in the Load *(L)* status or in the Run *(R)* status, selected with the Load/Run slider switch.

Load/Run: Select Load status – program accepts initialization commands – or Run status – program is executed.
Module No. 6: *(L)* – Loads module software into memory. *(R)* – Displays status of currently loaded software.
Test: Activates Display test.
Exit Recall: – Returns meter to normal operation from the Recall mode.
Special Function: *(L)* – Initiates entry of Special Function code which implements a minor modification to the standard program. *(R)* – Displays status of currently selected Special Function.
S: *(L)* – Initiates entry of "seconds" part of Preset Time. *(R)* – Displays status of "seconds" part of Preset Time, Duration or Real Time Clock.
Preset Time: *(L)* – Initiates entry of Preset Time which is used to set in advance a measurement period of up to 100 hours. *(R)* – Displays currently programmed Preset Time.
Duration: – Displays duration of current record.
Real Time Clock: *(L)* – Initiates entry of the current time into the Real Time Clock which is used in the documentation of a stored record. *(R)* – Displays the current time as measured by the Real Time Clock.
0: *(L)* – Zero.
Selector ▲: *(R)* – Used in conjunction with Mode, Time Const., Range, Channel and Displayed Parameter commands. Selects the next pre-programmed weighting, range or function in the series appropriate to the command.
Selector ▼: *(R)* – Ditto, except that the prior pre-programmed status of the parameter in the series is selected.
1: *(L)* – One.
2: *(L)* – Two.
NA: Not Applicable to this module. The position of this slider switch has no influence on the operation of the Meter.
NA: Ditto.
Mode: – Select the measurement mode in conjunction with **Selector ▲** or **Selector ▼**. – Check the status of Mode.
3: *(L)* – Three.
Time Const.: – Select the detector Time Constant in conjunction with **Selector ▲** or **Selector ▼**. – Check the status of the Time Constant.
Range: – Select "High" or "Low" sensitivity Range in conjunction with **Selector ▲** or **Selector ▼**. – Check the status of the Range.
4: *(L)* – Four.
Record No.: – Check the number of the record in which data is being stored.
5: *(L)* – Five.
Channel: – Select displayed Channel in conjunction with **Selector ▲** or **Selector ▼**. – Check the status of the displayed Channel.
6: *(L)* – Six.
Unit: – Select measurement Unit in conjunction with **Selector ▲** or **Selector ▼**. – Check the status of the displayed measurement Unit.
Displayed Parameter: – Select Display Function (Peak, Inst., a_{eq} etc.) in conjunction with **Selector ▲** or **Selector ▼**. – Check status of selected Display Function.
7: *(L)* – Seven.
Start: – Initiates a new measurement in the current record.
8: *(L)* – Eight.
Reset Record: – Resets all data in the current record and initiates a new measurement.
Stop: – Stops data storage, labels record and changes the status of the current record to the next empty record.
9: *(L)* – Nine.
Power Off/On: Switches the sound level meter on or off.

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